Vol. 19 SEPTEMBER 1946 No. 9

Instruments

THE MAGAZINE OF

Measurement and Control

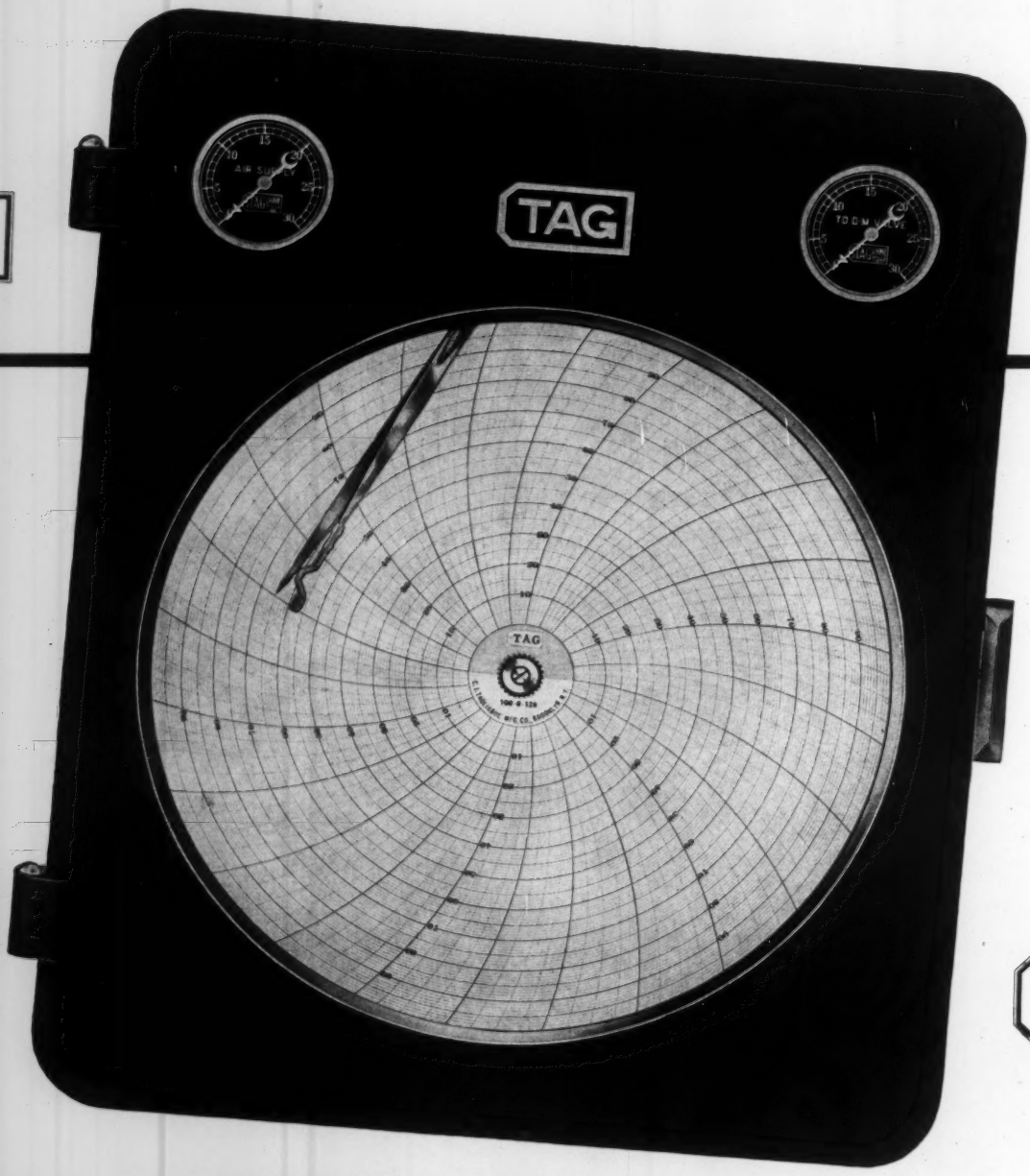
SPECIAL ISSUE

Instrumentation for Tomorrow

Conference and Exhibit

OF THE

Instrument Society of America



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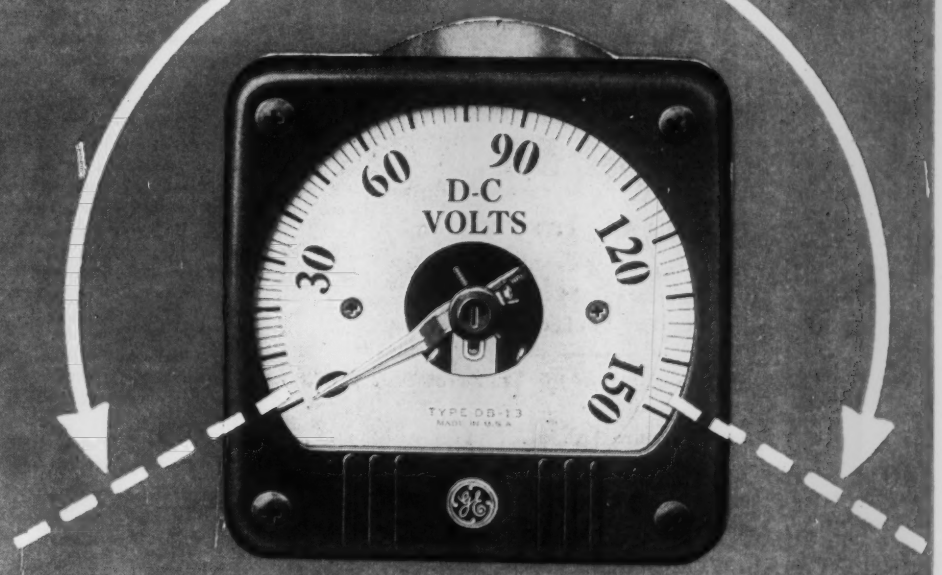

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THE MAGAZINE OF Measurement and Control

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Instruments THE MAGAZINE OF Measurement and Control

M. F. BEHAR, Editor

Instrumentation for Tomorrow

FOUR weeks from the time of writing these lines—one week after they are read by our subscribers—the first national Instrument Conference and Exhibit will open its doors. We have been asked to "open" it on paper.

At this time we have at hand advance copies of only a few special technical papers. We have no advance copies of the "keynote speeches" by Society officials and distinguished guests; hence no means of knowing what keynotes will be struck.

But TOMORROW is keynote enough!

It was nearly two years ago—when "tomorrow" evoked fervent hopes of the many blessings of peace—that "Instrumentation for Tomorrow" was adopted as the name and theme of the Conference and Exhibit. Now . . . peace is here—though only in the sense that the world's most powerful nations are not destroying each other's cities. Nevertheless, one can dream; one can hope; one can preach; one can plan; one can design; one can even invest money and effort in tomorrow's instrumentation.

That is precisely what the Conference and Exhibit represent: not only dreams, hopes and exhortations, but definite plans and designs—and the resultant tangible products yielding improved performance. Some of these products will be exhibited by their manufacturers (and we hope that no readers will quibble that these are devices of "today," not of "tomorrow"); others will be described by their designers in technical papers reporting various war-time instrument developments which have peace-time possibilities. The American Society of Mechanical Engineers sessions will be largely devoted to disclosures of war-time developments; the Physical Society of Pittsburgh session will be entirely devoted to such disclosures.

It seems to us, therefore, that the TOMORROW keynote, insofar as these new methods and new devices are concerned, is not a Jules Verne or H. G. Wells keynote but a keynote of the IMMEDIATE FUTURE.

It seems to us, moreover, that this is as it should be: because the thousands of visitors will derive APPLICABLE benefits; and because such a keynote will help assure the success of the 1947 Conference and Exhibit.

With this practical meaning of "tomorrow" in mind, we no longer hesitate to "open" the Conference. Our dominant thought is that the Conference will accomplish definite results, observable in the immediate future as an enhancement of the *importance* of the *functions* assigned to (A) instruments and (B) Instrument Men.

(A) The increasingly-important functions assigned to measuring and automatic-control instruments will be:

1. Minimizing the sum total of human drudgery, especially in eliminating repetitive operations and particularly in automatic dimensional gaging, automatic inspection of products, automatic grading, etc.;
2. Creating new and better kinds of jobs;
3. Bettering working conditions;
4. Labor saving in the sense of increasing productivity bringing about higher wages together with higher profits and lower prices;
5. Fuel saving and electric-energy saving in utilization, together with development of nuclear-fission piles as a practical new source of energy;
6. Materials saving;
7. Prolonging the service-life of processing equipment;
8. Increasing production from processing equipment;
9. Better quality of product;
10. Uniformity of product;
11. Minimization (sometimes total elimination) of rejects;
12. Minimizing reliance on human watchfulness;
13. Accident prevention;
14. Accelerating the conversion of batch processes to continuous processes;
15. Closer and closer control in both senses: (a) product control and (b) automatic control;
16. Great improvements in services rendered to the public by *all* of the fiercely competing transportation industries;
17. Ditto for the communications industries;
18. Continued improvements in meteorology, navigation, geophysical sciences, biological sciences, preventive and curative medical practices . . . and numerous other non-industrial fields depending increasingly on instruments;
19. Creating new industries and rehabilitating and expanding old industries.

(B) There will likewise be, in the immediate future, an enhancement of the functions assigned to the Instrument Man, be his title "mechanic in Section 6 of Department 17" or "President and General Manager." We shall not attempt to classify these human functions because many of them are naturally related to the foregoing list of instrument functions, and because to go beyond this province would necessitate dealing in boresome generalities. We feel safe in predicting specifically that the enhanced importance of the functions of Instrument Men resulting from the Conference will be accompanied by:

1. Enhanced status—increased recognition by others and increased pride in one's own job regardless of title.
2. Greater stability of employment—less and less dependence on "politics" or on the fortunes of wars between rival factions.
3. Relatively higher percentual raises in pay—we say "relatively" because the specific prediction we have in mind is that Instrument Men's salaries and wages will first catch up with the rest of the increases. Afterward . . . well, perhaps this will be a mission for the 1947 Conference to accomplish!
4. Closer association of Instrument Men with one another through the expansion of existing ISA Local Sections and the formation of many new ISA Local Sections.
5. Closer association of instrument-minded engineers, technicians, scientists, executives, educators, etc., with one another through greater official interest in Measurement and Control within existing societies. (A shining example is the IIRD of the ASME, which George A. Stetson, Editor of *Mechanical Engineering*, calls "a technical society within an engineering society.")
6. An enormous increase in instrument education—and by "enormous" we mean a 50% or perhaps 75% *quantitative* increase based on 1947 enrollments as compared to 1946 enrollments in courses on Instrumentation subjects.
7. A corresponding — but not measurable — *qualitative* improvement in instrument education: more basic principles, such as dynamics, rather than more hours devoted to teaching special skills.

—MFB

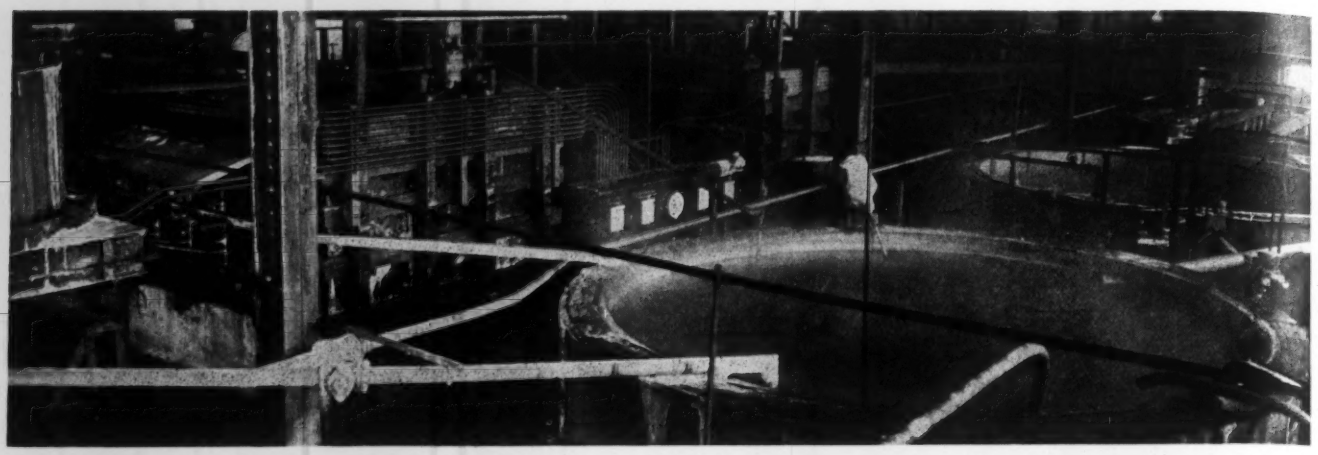


Fig. 1. General view of automatic-control installation.

Automatic Control of the Neutralization of Nitric Acid With Ammonia

By S. A. HARVEY, Works Manager, and P. R. EWALD, Electrical Engineer,
Tennessee Valley Authority, Wilson Dam, Alabama

ABSTRACT

Large-scale neutralization can often be a delicate procedure whether carried out manually or automatically. After a number of trials using conventional neutralization methods which resulted in difficult operation and appreciable losses, the TVA Nitrate Plant adopted the two-step system described here which greatly simplified operation and increased the capacity of the equipment from 300 tons per day to 500 tons per day.

THE PROCESS

IN the TVA plant the production of ammonium nitrate involves the neutralization of nitric acid with anhydrous ammonia. The pH of the liquor is used as the basis of control. As shown by Fig. 2, there is a large change in pH as the equivalent proportion of ammonia is approached. Experience showed that in batch operation an excessive amount of operator attention was needed to neutralize a tank, particularly as the desired pH of 6.4 was approached. In continuous operation, supply fluctuations made it impossible to manually hold the neutralizer tanks at the desired pH without frequent overruns to high pH. In automatic operation, attempts to complete neutralization in one step showed that because of the steepness of the pH *vs.* concentration curve at pH 6.4, the high rates of flow used, and the difficulty of complete mixing, frequent momentary overruns to high pH could be expected. This resulted in loss of ammonia at the high pH, and was further complicated by foaming which developed at pH higher than 2. The result of these experiences was installation of the two-stage control system described here.

The neutralization of the nitric acid is accomplished in two steps as shown in Fig. 2. In the first step, approximately 42% nitric acid at 25 gpm. and somewhat less than its equivalent of anhydrous ammonia at 20 to 50°F. and 25 to 40 lbs./in.^{2} are fed simultaneously through perforated distributing pipes into tanks which are 10 ft. in diameter and 10 ft. deep (5,900 gallons). The tanks are provided with internal steam coils to supplement the heat of reaction and thus to evaporate part of the water from the solution. From these tanks, one of which is shown in Fig. 3, the partly neutralized solution flows by gravity to an adjusting tank where the final addition of ammonia is made. This tank is 16 ft. in diameter and 5 ft. deep (7,500 gallons) and is equipped with a 2-hp. mixer. From the adjusting tank the practically neutral solution of ammonium nitrate is drained into storage tanks.

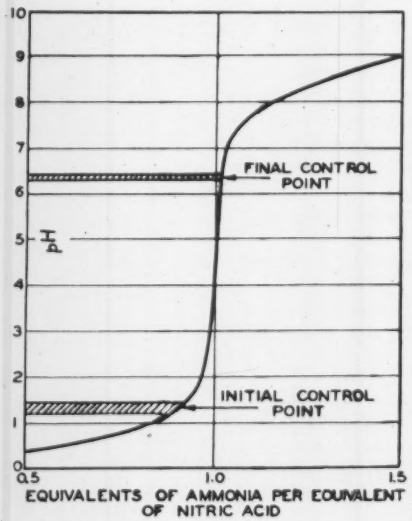


Fig. 2. Typical curve for the titration of nitric acid with ammonium hydroxide.

CONTROL OF INITIAL STEP IN THE NEUTRALIZATION

Most of the ammonia required for neutralization of the nitric acid is added in the first step of the process. The heat liberated by the reaction, together with that introduced through the steam coils, causes boiling of the solution with resultant formation of a foam which complicates the control of this step in the neutralization.

A portion of the partly neutralized solution from each unit of the installation is diverted from the overflow line to a catch basin as may be seen in Fig. 3. Several small holes below the main opening to the overflow pipe, as shown in Fig. 3, insure the continuous flow of liquid to the electrode assembly during liquid level fluctuations in the tank. Water cooling of the sample brings the temperature to about 160°F., which is within the effective temperature range of the glass electrode used (125-200°F.).

Each pair of electrodes, along with its temperature compensator, is connected to a strip chart recording pH controller, with a chart speed of 1 inch per hour and a pH range of 0 to 8. The control slide-wire covers 40% of the full scale range. The controller, provided with adjustable positioning and floating actions, operates a 4" electric-motor-driven valve which regulates the input of ammonia.

Satisfactory operation in the initial

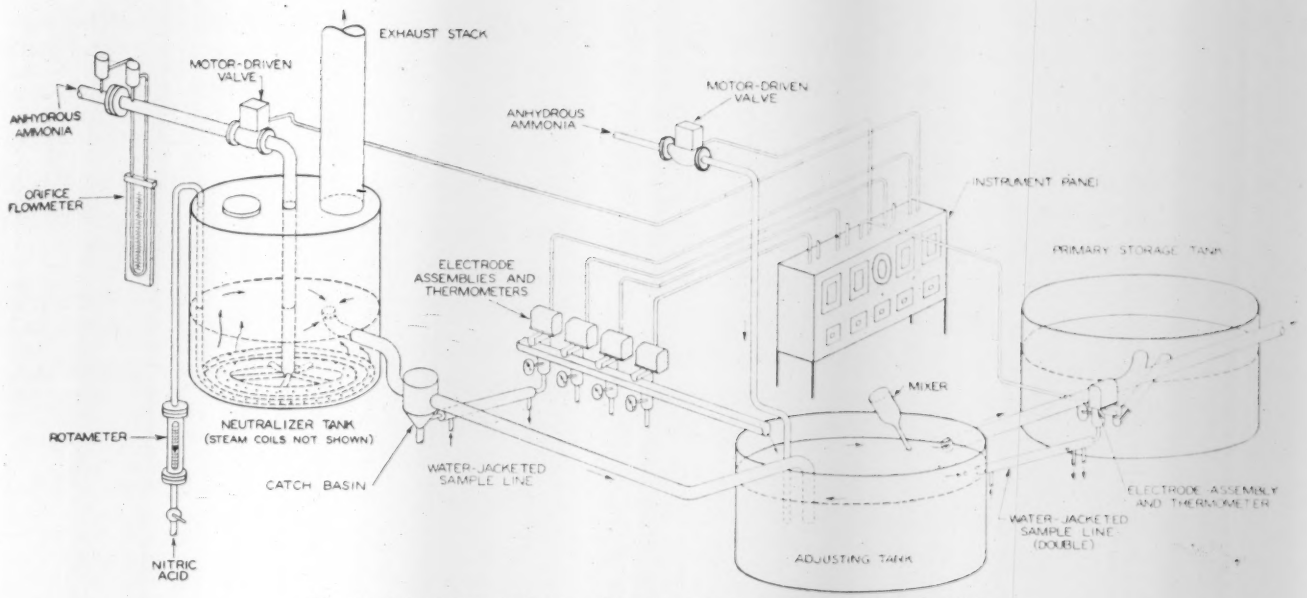


Fig. 3. Automatic-control system (showing one of the four neutralizer tanks).

step of the process without mechanical mixing has been obtained in the pH range 0.6 to 1.4. At higher pH, frequent overshoots take place with resultant loss of ammonia and excessive foaming. This foaming would often cause the tank to overflow, sometimes violently. At lower pH, small errors in measurement are reflected as substantial deviations in the proportioning of the reactants.

The pH is kept within the control range with the control set for a positioning range of about 15% of the controller range and for a fairly slow floating rate. The narrow positioning range is appropriate because of the relatively large capacity of the tank and the small change of the pH with changes in the composition of the solution near the control point (Fig. 2). The slow floating rate is desirable because of random fluctuations in the composition of the solution due to incomplete mixing.

Control of Final Step in the Neutralization

The final addition of ammonia is controlled by a system similar to that used for the initial step in the process. The recording pH controller for the final step in the neutralization is a 24-hour round-chart type with a pH range of 2 to 12 and a control slide-wire which covers 20% of the full scale range. For this step, the controller drives a 1″ electric motor-driven valve to regulate ammonia input.

Because of requirements in subsequent operations, final adjustment is made to pH 6.4, which represents a slight excess of ammonia. The pH is held to within ±0.1 pH unit of the control point with the control set for a positioning range of about 150% of the controller range and with a relatively high floating rate. The wide positioning range is necessary because of the sensitivity of pH to changes in the composition near the control point (Fig. 2), and the rapid floating rate is permissible because of the thorough mixing in the adjusting tank.

Some Installation Problems

The neutralizing equipment is housed in a structure that was not designed for this type of operation. The fumes and water vapor from the material in process saturate the air in the building (see photographs, especially Fig. 5) and condense on the equipment as a corrosive and conductive film, forming short circuits for the sensitive electronic equipment used. It is necessary, therefore, to maintain a protective coating on all exposed surfaces and to keep the instrument housings tightly closed. The heat from the motors and vacuum tubes keeps the temperature inside the recorder-controller cases above the dew

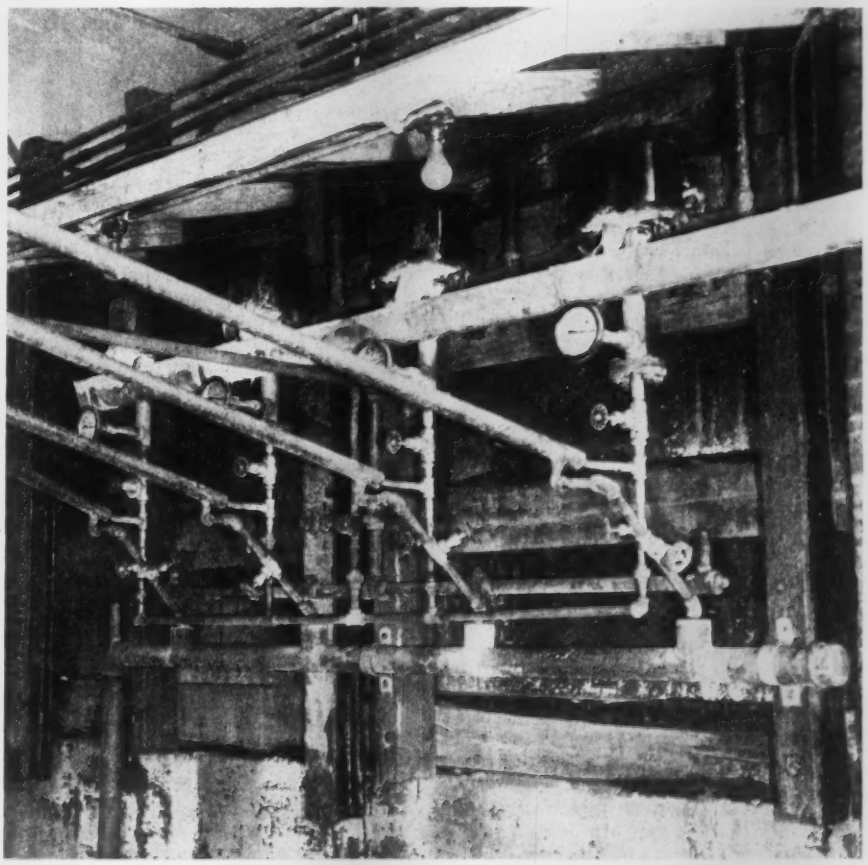


Fig. 4. Electrode installation for neutralizer tanks.

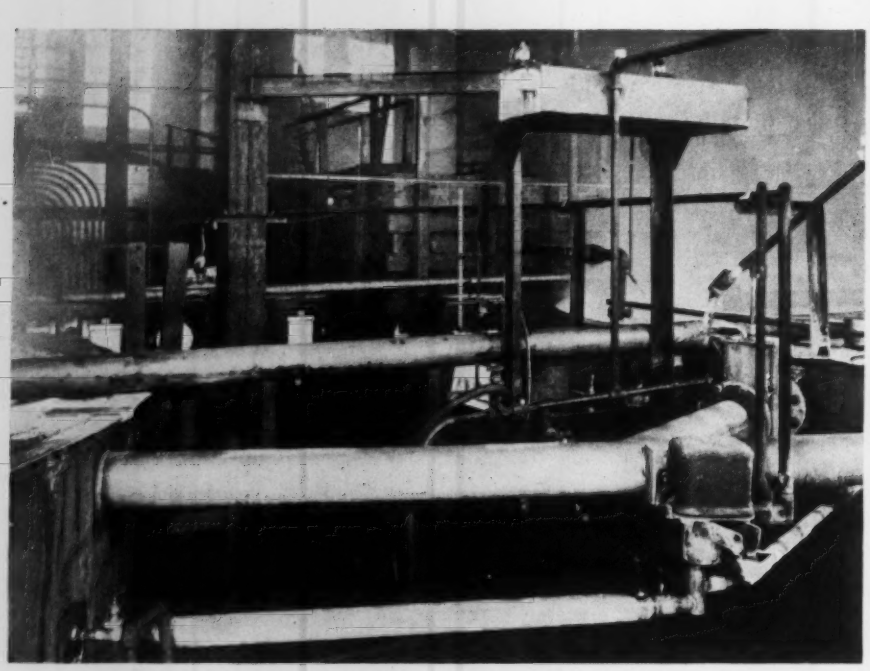


Fig. 5. Electrode installation for adjusting tank.

point. Heat is provided in the electrode housings by electric light bulbs.

The accumulation of foam in, as well as corrosion of, the electrode chambers was eliminated by designing special stainless steel chambers having open spouts for the overflow, as may be seen in Figs. 4 and 5.

The catch basin located at the sample point was found necessary in this process because of impurities in the acid from brick absorption towers. It is designed as a conical trap from which the sediment may be drained off at the bottom.

A general view of the installation is shown in Fig. 1.

Improvement in Operation

The neutralizing equipment was originally designed for batch operation at 300 tons output per day. Changing to a continuous system permitted an increase to 500 tons per day using the same equipment. The automatic system permitted the increase with no additional personnel; in fact, the burden on the neutralizer operators was greatly decreased. Use of the system described prevented pH overruns beyond 7 with attendant loss of free ammonia as experienced in manual or single step automatic operation. Installation of the system in 1942 proved to be timely with increased production and manpower at a premium.

Acknowledgment

Contributors to the installation were C. Fenoglio (Instrumentation), F. H. Haynie (Design), C. Rose, D. W. Reed, and G. Stoltz (Operations).

A High-precision One-inch Electrical Extensometer

By H. M. MAHAN, Northrop Aircraft, Inc., Hawthorne, Calif.
and Wm. B. WARREN, Statham Laboratories, Los Angeles, Calif.

In conducting some long-term studies of strain in large structures, the logical instrument appeared to be one which embodied the simplicity and sensitivity of the electrical resistance strain gage. The bonded-wire strain gage has reached a high degree of development as an efficient tool for measurement both of dynamic and short-term static strain. It is the purpose of this article to describe a gage applicable to long-term studies, which retains the simplicity and sensitivity of the bonded-wire strain gage.

The requirement was for an instrument which could measure with extreme precision the distance between numbers of pairs of gage points on the subject structure, at any time during a test period which would extend over months. The resultant instrument is a joint development of the Northrop Aircraft Company and of Statham Laboratories and embodies an adaptation of the Statham gage manufactured by Statham Laboratories.

The Statham gage embodies a series of four fine-wire elements mounted under initial stress between a fixed frame and a movable armature and electrically connected in the form of a Wheatstone bridge. Movement of the armature with respect to the frame causes two of the bridge elements to increase in resistance and the other two (diagonally-opposite) simultaneously to decrease in resistance, thus producing a fourfold amplification. Since all four arms of the bridge are close to one another and since complete electrical symmetry exists, a high degree of stability is attained. Effects of temperature change on the Wheatstone bridge are automatically compensated. Likewise, since all electrical and mechanical structures are contained within a strong case, they are effectively protected from mechanical injury.*

The basic Statham gage was modified by mounting two "doughnut shaped" clock jewels in its structure. One was mounted in the frame and a second, exactly one inch distant, in the armature. Two holes were provided in the case: one immediately above each of the two jewels. The complete extensometer is $1\frac{1}{16}'' \times 1'' \times 2\frac{1}{4}''$ and weighs 3 oz. Fig. 1 shows its appearance after rugged use.

The extensometer is used to measure the distance between gage points which are cemented to the subject structure with the same cement used with bonded strain gages. The gage points are standard steel phonograph needles mounted in aluminum bases.

With the gage points properly located with respect to each other on the test structure, it is possible to measure precisely the distance between them with respect to a 1.000" standard, by pressing the electrical extensometer down upon the points of the needles so that they pass through the holes in the case and enter the jewels located in the frame and armature, respectively. In measuring 1" lengths the accuracy of the instrument is limited by the accuracy of a 1" Invar Standard. But in measuring *Increments* at 1" separation, accuracy is limited only by reproducibility. Strain measurements involve largely incremental measurements. Within the limits of measurement ($\pm 0.002''$), the needle points always enter the jewel holes, but not necessarily exactly along the axes of the holes. Only slight pressure, however, causes the jewels to be shifted so that their holes are exactly centered on the gage point needles; the extreme ogival shape of the points and the toroidal shape of the jewel holes presenting a sort of cam system.

Any relative movement of the jewels must, of course, result in movement of the armature with respect to the frame and a consequent bridge unbalance

*For discussion of principles and detailed descriptions of instruments see "Applications of Unbonded-type Resistance Gages" by R. D. Meyer, *Instruments*, Vol. 19, 1946, pages 136-139.

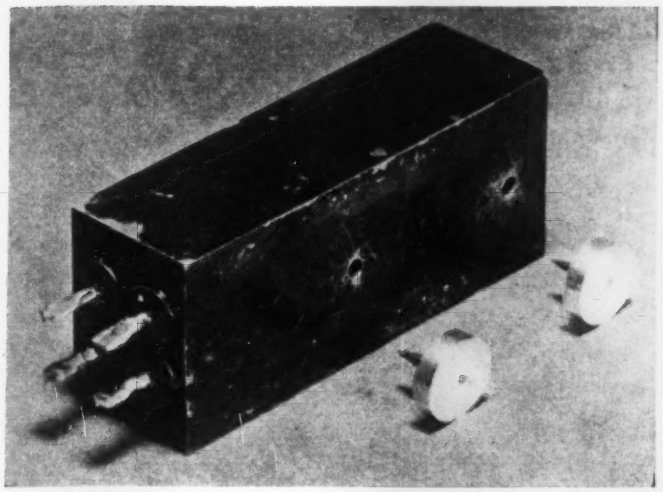


Fig. 1. Electrical Extensometer and two Gage Points (actual size).

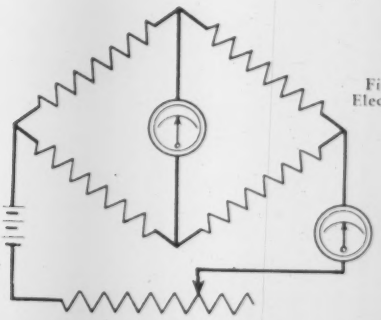


Fig. 2. Circuit of Electrical Extensometer

Fig. 3. Gage Points used with Electrical Extensometer (actual size).

which can be read on an indicating instrument. After calibration of the extensometer, indicating-instrument reading can be interpreted in terms of distance between the axes of the gage points under test.

The actual manipulation of the pick-up unit when taking readings is simple, as is evidenced by data obtained by two different operators. The two main criteria are: (1) that enough force to hold the pick-up firmly in place be applied, preferably by the index finger, normal to the pick-up top at a point approximately halfway between the gage points; (2) that the bottom of the pick-up case be oriented, as nearly as possible by eye, parallel to the surface on which the gage points are mounted.

With auxiliary equipment, later to be described, gage points in pairs may be located in unlimited number at pertinent positions on structures to be tested and measurement of separation conducted at any time.

The Electric Circuit

The simple electric circuit is shown in Fig. 2. Power is supplied at 12 volts and 50 milliamperes from dry cells which, at this drain, require infrequent change. Current output readings are taken with a Westinghouse Type RX-37, 0-100 microammeter. The only adjustment required is to insure that the current is 50 milliamperes, within limits established by the input current meter, which was a GE Model AVS 62-1 0-100 milliammeter—smallest division 2 mils.

Range and Precision

With circuit conditions noted, current output is approximately 100 microamperes for 0.002″ movement of the armature with respect to the frame. The Statham gage is so constructed that movement is possible in both positive and negative sense, but limited by a stop to 0.0020″ in each direction. Since the indicating instrument can be read to 1% of full scale, and the meter jewels are set 1″ apart, it should be possible to read a dimensional change of 1% of 0.002″ per inch. Actually, the reproducibility of the complete system is plus or minus one scale division. Hence, the system is suitable for measurements within the range ±0.002″ with an uncertainty of 0.00002″.

The Gage Points

The phonograph needles are the gage points, Fig. 3, on the system under study. They are mounted in aluminum bases 0.4″ in diameter and 0.1″ high by driving them through a tight press-fit hole which is drilled through the center of the base. This assembly is cemented to the structure under study with the aid of an adjustable gage block. In considering the basic problem of two circular base plates cemented onto a surface, the question arises whether or not the distance between the plates will vary directly as the surface is elongated or compressed. The cement film, being in intimate contact with the surface, will certainly change in dimension in the direction of the strain. However, if it may be assumed that this is a lateral extension or compression of equal magnitude in both directions, it will be evident that the film is merely transformed from a circular to an elliptical one, but that the center of the figure remains fixed. Hence, the needles are centered within the base plates to within 0.0005″ and the error due to off-centering will be but 0.1% on a 1″ gage length.

The Gage Block

It is necessary to locate the gage points at a precisely known distance from each other so that the gage will be in the middle of its travel when it is pressed down upon them. The adjustable gage block, Fig. 4, is a block of steel, ½″ square × 1½″ long, which carries cylindrical parts, ⅜″ in diameter which extend ¼″ above the surface at each end. Each cylinder has a hole drilled along its length which is identical in diameter with the internal diameter of the hole in the clock jewels in the extensometer. The hole in one cylinder lies along the axis of the cylinder, and this cylinder is pressed tightly into the block. The second cylinder is a tight fit in the block, but can be rotated, and its hole is 0.001″ off-axis. With a nominal separation of 1.000″ between the cylinders, turning of the rotable cylinder permits adjustment of the spacing within the range 0.999″ to 1.001″.

The Invar Gage Standards

The adjustable gage block, shown in Fig. 4 with two gage points resting upon it, is set by pressing it down upon two phonograph needle points which are permanently mounted in an Invar block, at an interval at the mid-range of the extensometer. It is possible very precisely to match the spacing of the holes in the gage block to the spacing between the needles in this Invar Gage Standard, Fig. 5. When the slightest difference exists the gage block will rock; when a perfect match is made, rocking is eliminated.

When the gage block is properly set, it is used as a jig to locate pairs of gage points on the subject structure by pressing it down over them until the cement has set. With pairs of gage points thus set at intervals within the range of the extensometer, the separation of each pair can be measured at any time by pressing the extensometer down upon them. After calibration of the extensometer, the current flow which results from bridge unbalance can be interpreted directly in terms of inches separation.

Calibration

The instrument was calibrated by use of a test bar (Fig. 6) of metal of known modulus of elasticity, constructed in the form of a standard tensile test specimen, on the two faces of which a pair of gage points was cemented. Pairs of test runs were made, readings of strain being taken first with a bonded strain gage and subsequently with the electrical extensometer. In Fig. 7, calibration data are plotted. The points plotted are averages of readings taken on opposite faces of the specimen to

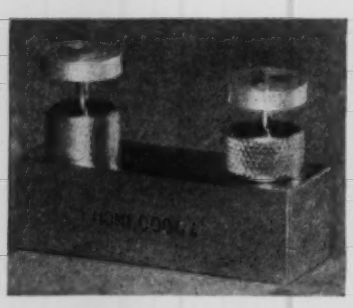


Fig. 4. The Adjustable Gage Block with two Gage Points resting upon it (actual size).

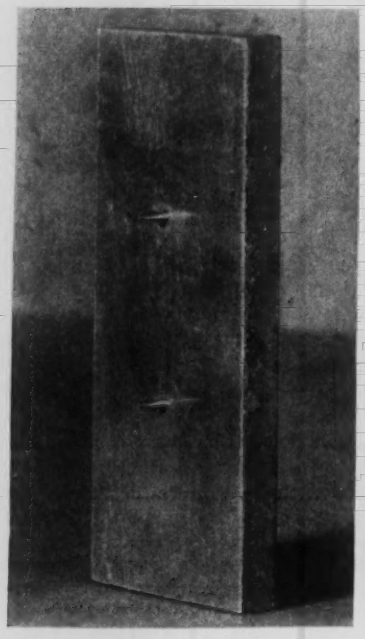


Fig. 5. The Invar Gage Standard (actual size).

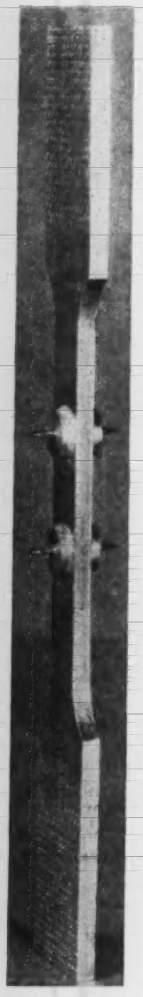


Fig. 6. Test Bar (about 2/3 size).

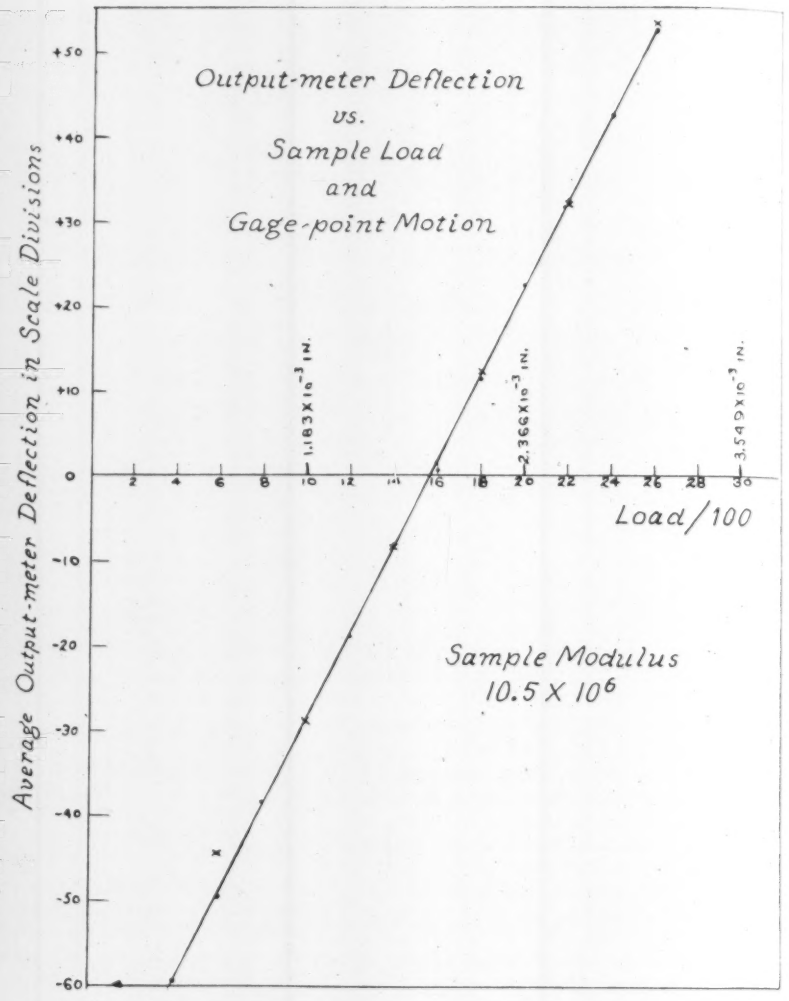


Fig. 7. Calibration Curve.

eliminate effect of bending. The strict linearity of the function relating electrical extensometer reading and strain is evident.

Since the calibration curve is known to be linear, subsequent calibration is simple. An Invar Gage Standard containing two pairs of needles, separated by known intervals within the range of the extensometer, permits establishment of two points on such a curve. With the intervals known and recorded, a number of extensometers can be calibrated in a short time. Likewise, if the readings for the two pairs are recorded for each extensometer when they are first constructed, any extensometer may subsequently be checked.

The Invar Gage Standard has a pair of gage points spaced as precisely as possible at 1.000". All test data sheets must include a record of the output meter reading of this pair of gage points, taken before and after each series of test readings, to eliminate instrumental and personal error and establish a reference. This permits use of any number of extensometers over an extended time period, since all readings may be interpreted as increments to the spacing of the points on the Invar Standard.

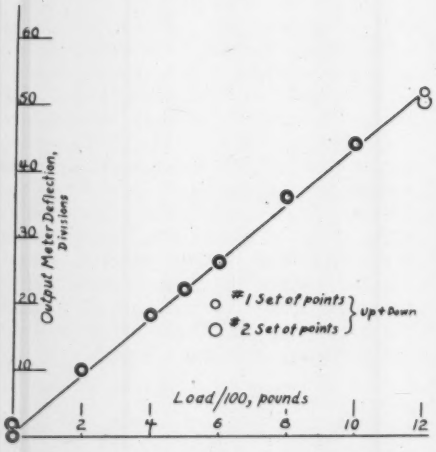


Fig. 8. Plot of Results of Compression Test.

Hysteresis

Fig. 8 shows results of a compression test on a block of metal on the face of which two pairs of gage points were mounted side by side. The block was placed under low compression stress so that it was always on the linear portion of its stress-strain curve. The large circles represent readings on one set of gage points and the small circles show the readings on the second pair. Data were recorded for both increasing and decreasing load and it is clear that no measurable hysteresis exists.

Stability

Reading of the separation between two pins in an Ivar Standard made on 1/17/46 agreed with those taken on 12/22/45 within 6 microinches in a total separation of approximately one inch.

Reproducibility

In Table I are shown two series of readings of the same pair of gage points. Observer A was experienced, while Observer B had never before used the extensometer. He was asked first to watch Observer A make his

Table I—Reproducibility Test.

	Invar Std.		*Points Glued on Aluminum*	
Contact	*Obs. A*	*Obs. B*	*Obs. A*	*Obs. B*
1	4.0	4.0	14.0	12.0
2	4.0	4.0	13.5	14.0
3	4.0	4.0	14.0	13.5
4	4.5	3.5	14.2	13.5
5	4.5	4.0		
6	4.5	4.0		
7	4.5	4.0		
8	4.0	4.5		
9	4.0	4.5		
10	4.0	4.5		
Average	4.2	4.1	13.9	13.3

series of measurements and then to make a similar series.

Increasing Sensitivity

The sensitivity of the system may be further increased by mounting the gage points on bars which pick up strain over a greater length of structure.

Applications

The simplicity and stability of the installation is such that massive and complex indeterminate structures could be literally peppered with pairs of gage points at little expense. The light weight and portability of the instrument would reduce the labor of taking readings to a minimum. Gage points may, of course, be removed and replaced at will.

The tie-in to the permanent, stable Invar Standard is a basic and fundamental procedure for long-term strain studies.

These features suggest the possibility of mounting gage points on permanent structures such as bridges, dams, roof trusses, and the like with the idea of keeping constant check on such structures. In this case, it is possible that superior results might be obtained by employing tungsten carbide gage points which would resist the corrosion and wear which might accompany repeated testing. A simple cover could be placed over each pair, both to protect them from mechanical damage and to make location easier.

Accurate temperature data must be taken when taking extensometer readings in order to discern strains due to load. Creep studies, both in the laboratory and in the field, should be simplified by use of the electrical extensometer. Likewise, the possibility exists to affix gage points permanently into moving components of structures and to follow the course of permanent deformation. For example, results of such a study on a locomotive connecting rod might be most revealing.

In short, wherever information on the distance between two points is required to be determined with precision, and that distance is anywhere within the range of one inch to one foot, the electrical extensometer would find useful application.

Research and Economics

By PAUL G. WEILLER, Engineering Consultant, New York City

INDUSTRIAL research may be defined as any activity striving toward the development of new or improved processes or products. If this definition, which I believe to be strictly logical, is accepted, industrial research has gone on since about the middle of the 18th century.

In the early days, it was carried on in shops and factories without much assistance from the exact sciences. About one hundred years later, industrial laboratories began to crop up here and there; at first mainly devoted to quality control.

From then on, the share of the laboratory has slowly increased until toward the turn of the 19th century the research laboratory was divorced from the process and control laboratory and supposedly the research laboratory was devoted entirely to the search for that elusive perfect process or the product which would out-sell all others.

Be it granted that a great deal of psychology is involved in the process. This article is, however, devoted entirely to the economic side and we will skip over any eleemosynary side of research to bear down on the more selfish part of it.

The readers of *Instruments* will agree that whatever the motives of the industrial research workers are, research itself has a definite place in our economic fabric. In the long run, it must pay its own way and must pay well. If it did not, it would soon be classified as a luxury and be discarded.

On a national scale, research certainly has paid off hugely. This is true both as to benefits to the nation as a whole and to monetary returns to the organizations which have invested in it. It would not be amiss to emphasize that our entire modern life is based on the results of two hundred years of industrial research.

To these statements there will be hardly a dissenting voice—and yet, has research reached the rank and place it deserves in our economy? Does the average company consider the research laboratory as part and parcel of the entire profit-making organization, as, for instance, the advertising and publicity departments?

Engineers—and instrument men in particular—are well aware that the answer is NO.

A man I knew well years ago started a patent medicine business with a $50,000 advertising appropriation, paid for out of his own pocket. He had an idea, a product, a package design—and no plant. For a while, the production of the product was farmed out to whoever was willing to make it.

It is an accepted fact that most products, and consumer products in particular, must be publicized to reach satisfactory sales volumes within a reasonably short time. Therefore, every well-conducted business will devote a certain percentage of expected sales to advertising.

Advertising and publicity expenses may run 3%, 5% or even 10% in some particular products, but the emphasis is not on the amount, it is on the concept of expected sales. It is generally conceded that one must spend money for advertising in advance of any profits or other gains obtained therefrom.

Is this true for research appropriations? A few of the largest companies maintain research expenditures which run into huge figures. Compared with the expenditures of the same companies for advertising, the amounts spent for research loom less large. The companies with the huge research expenditures are few and they are those which, during the half-century just past, have reaped large benefits from new products and processes.

The expansion of research activities has been only an afterthought, based on past experience, and not an expenditure decided upon in advance as essential to further success. This is even more true for the numberless companies of average success and even for many of the very successful ones.

In spite of the war-inspired ballyhoo about research, new inventions, miraculous weapons and spectacular progress in the art of healing, the research laboratory is still considered by many as an expensive luxury which will pay dividends only to the lucky.

During the frequent and prolonged periods of hard times between the two wars, the cuts in research departments were notorious. In fact, when it came to cutting personnel because of bad business, the research departments were hit first. Often, at the same time, expenditures for publicity were increased in a usually successful effort to lure new customers to the establishment.

Is there any logic in the favoring of publicity and the neglecting of research as a means of restoring prosperity? Decidedly not! Increased expenditures for publicity are logical and wise but what is sauce for the goose is sauce for the gander. A speeding up of research—by increasing the expenditures for it—is just as logical and useful as an increase in expenditures for publicity.

Let me substantiate this claim with a very homely example. During the depression, I knew of an effective spot-welder control which was being marketed with some success. This control was often used to take care of difficult welding jobs. A brass company, for instance, took a contract for half a million nickel-plated flash-light cases. For reasons of his own, the buyer specified that the case should not be eyeletted as was customary. He wanted them spot-welded after plating, the welds to be invisible.

The company was hungry for business and took the contract. Consequently, they had to purchase the new automatic controls. The contract was successfully completed.

Later on, when business became more normal, the same brass company refused contracts which were difficult to

execute and marketing of special automatic controls became more difficult.

The appearance of these controls made working profits for the manufacturer and they enabled the brass company to employ a substantial number of people on work which would not have been available otherwise.

In times of depression, the market for standard equipment shrinks by a considerable proportion and the market for new types of equipment, or special equipment, improves because it enables the purchaser to produce new types of products which can be marketed even during a depression.

The example related here is not just an interesting story. It is typical of depressions and similar occurrences repeat themselves in all industries.

It has been justly stated that the depression of 1921 was lessened by the advent of the radio business in large volume. But it might also be said that the disappearance of the billion-dollar liquor business had a lot to do with causing the depression of 1921, or at least with making it worse in 1929-1933 after the "hectic twenties" of false prosperity.

There are other factors which operate in the same direction. During periods of brisk business, the average factory man is reluctant to make changes in equipment because he is afraid that changes might make trouble. During depressions, he is willing to try anything which can be remotely expected to bring any new business and which can also kill some of the time he has on his hands.

I believe we have established by sound reasoning that in times of depression research expenditures should be expanded and not contracted. I believe that many readers of *Instruments* have had similar experiences and will agree with me.

Research expenditures, wisely handled can, of course, make as much of a contribution to prosperity in good times as in bad, although their effect might be less obvious except in some spectacular cases.

Of the latter, nylon is a conspicuous example. This product was the almost fortuitous result of a million-dollar appropriation for *pure* research — or at least so the tale goes.

Unfortunately, there is little understanding of the economics of research, even in ordinarily well-informed quarters. The idea that research is mostly a gamble seems to have nine lives and is hard to kill. Going further into detail, the hazard which seems to frighten management most is the time factor. No one is willing to predict the time necessary to complete a research project from first conception to working model. On the face of it, the fear of the endlessness of some research projects is justified; *in fact, this fear is not justified.*

Many years ago, I heard a paper delivered by a prominent research director who had made a study of the time factor in his company's projects: he claimed that it took them between five and seven years from first idea to a semi-commercial product. If we accept this figure as typical, it would, of course, explain the reluctance of management to make large research commitments in the face of declining business. The results seem too far away.

It is quite reasonable to ask ourselves whether the average research project *must* stretch over a good part of a lifetime, or whether these long periods are the consequence of the haphazard way in which most research projects are entered.

It seems to me that many of the economic difficulties of research are due to lack of faith and the haphazard handling of projects.

Among the things which delay the fruition of research efforts and make research departments a costly appendage are the many ill-founded trouble-shooting projects which are dropped into the lap of the research staff. It goes about like this:

The telephone rings. The General Manager or his assistant is in quite a huff and says, "Oh, Paul, we have recently had so much trouble with our XYZ finish. It is just too tacky in summer. The supplier does not seem to do anything about it. Can you help?"

A request by the General Manager is, of course, law. Anyway, Paul wants to be obliging, so he puts someone to work on the project in a hurry. One week goes by; another and another. Meanwhile, some other more satisfactory finish has been located from another source. The whole matter has been forgotten — but the research department has not been notified!

Or another one: "We must have cement which is easy to apply, insoluble in water, aliphatics and aromatics, and easily removable in case of repairs."

The cement was to have been used to fasten a glass window on an instrument. Later on, the glass window was omitted entirely and all work done on the cement became useless.

I should say that, in many cases, more than half the time of a research staff is devoted to projects which should never have been started.

Among the latter are also many which are not important enough to warrant a great deal of effort and expense. They are started and carried on in a half-hearted way and then dropped because of increasing expense.

One day, my section head handed me a letter with the blue pencil marginal note, "What about barium getter?"

I found that another man in the department had done some work on the subject and found barium a good getter but in no way superior to the older magnesium getter in connection with practices current at that time. (Later, after radical changes in the process had been made, barium became a standard getter.)

I reported the conversation to the section head and suggested that the project be dropped. He was horrified and said, "Dr. X asked about barium getter and you have to work on barium getter."

So I did. It involved expensive work stretching over a period of four months. A detailed report with reams of tabulation was compiled. The result checked exactly the findings of my predecessor. The report went to join the previous report somewhere in the files and was never read by anyone.

This is another practice which makes research work prohibitive. This project should never have been undertaken.

There is one principle of research economics which I believe should be basic. With the tremendous amount of new knowledge stored up during the two or three decades past and never used; with the improvements in laboratories, process and fabricating equipment available to modern industry, almost any reasonable, and many unreasonable, demands for material or product specifications can be complied with. In plain English, this means that we could build a floating bridge across the Atlantic Ocean if it were economically justified.

Therefore, the first question the research director must ask when a project is assigned to him is this. Do you want this job finished regardless of cost or not?

If the answer is No, the project should not be started unless preliminary tests have indicated that the end can be attained with little effort. I believe that much more than half of the cost of research up to date has been caused by half-hearted projects which have been abandoned after substantial sums have been expended on them.

Here is a striking example. We were working on the improvement of an instrument which had been in production on a small scale for some years. Its use could be expanded only by improving its accuracy. A thorough analysis of its operation showed that an improvement in accuracy could be obtained only if it were possible to produce a complicated part, at that time made of molded Bakelite, with tolerances of 0.001″ or preferably less.

It was quite impossible to mold Bakelite on a large scale to anything like such tolerances. Prolonged and expensive efforts to machine Bakelite moldings were a total failure. It appears that machined Bakelite moldings have a way of alternately shrinking and swelling for no easily-apparent reason and, what is even worse, the process of distortion never ends.

We tried injection-molded dielectrics, polystyrene and several others. These were dimensionally stable at room temperature but were unreliable at the service temperature of the instrument.

Machining tests were made which indicated that, under proper conditions, *laminated* Bakelite could be produced with the required accuracy and dimensional stability. The samples in question were produced by methods which would have been quite impractical for mass-production purposes. All of the

well-known Bakelite fabricators refused the job as impractical.

I went to the manager with the results of my work and told him that we had produced some satisfactory spools in the research department but that there was only a faint hope of evolving a practical manufacturing method and that, at any rate, the cost of further work on the project would be high and its extent unpredictable.

His answer was, "We must get good spools. Go ahead."

This involved some six months of work with from one to three first-rate machinists engaged on it and it meant the purchase of a special machine tool on the faint evidence that it would do the job.

The final result was a method of grinding laminated Bakelite under water at high speeds and pressures, combined with an entirely unconventional process of coating a few surfaces which could not be conveniently ground.

The method finally became entirely automatic, taking only eight minutes of labor where it had taken an hour by the old methods. Instead of variations of 0.006", dimensions were kept within 0.001" for most dimensions and 0.0005" for some. It did not require the attention of highly-skilled personnel. The expenditure for equipment was close to $10,000.00. The project took about a year to complete. It was an unqualified success.

Most abandoned research projects would have ended in success if pushed energetically and with the conviction that they must be completed. And again, if the importance of a project does not warrant such treatment, it should be abandoned when the first difficulties appear.

An example where the research project was abandoned after preliminary tests because, under the prevailing conditions, it was not worth a large expenditure of money, is the following.

We heard of a patent covering the first piercing of blanks for instrument jewels by an electric spark. (At that time, a serious shortage of special jewels seemed to be in the offing.) We spent two weeks trying to duplicate the results described in the patents. We found that a spark under water would really attack the sapphire but the cavity seemed to be irregular and it also appeared to be difficult to obtain sufficient depth.

It became quite evident that a great deal of work would have to be expended to discover the proper conditions for satisfactory operation. Meanwhile, some new sources of jewels had been found and the project was abandoned as not worth the expenditure of a large amount of money.

I understand that some manufacturers are actually using the process. As we were essentially instrument-makers and made our own jewels only as an emergency measure, completion of the work would not have been worth while.

Many of you would probably say that a research director would have to have the courage of a lion to think along these lines. Can he gage the risks involved in trying to predict the outcome of research projects? If he is the right kind of a research director, I believe he can. He can and should and, what is more, he should be right about eight or nine times out of ten. If he can hit that kind of a batting average, no one will blame him for the few misses.

One other point is worth making. A research project in a well-conducted research department should not be lightly started. We must realize the fact that, owing to the spreading of technical education and the enormous number of things which might be done and haven't been done, good ideas are so plentiful today that they are worth just about a dime a dozen.

On the other hand, the only economically worth-while result of a research project is either a saleable product or an improved process. When some of the bright young men came to my office parading their ideas, my answer was this:

The General Manager is a brilliant technical man, full of ideas. The Chief Engineer is no slouch and has plenty of ideas. I must admit to some myself. If we attempted to put only the ideas of these three men into practice, the company would be broke in less than two years.

While we are very open-minded and are willing to accept ideas from many sources if they happen to fall into line with our development program, we are not looking for ideas with a candle.

There are plenty of things on the shelves. What we are looking for and what we are willing to pay for, are men who can take either their own or other people's ideas and convert them expeditiously into usable processes or products. Some men have an uncanny gift in that direction; others will always be tyros in this game.

Many of the important advances in the technical arts of the 19th century have had their success in work undertaken at random because some one had a good idea. As there was no definite conception, in the beginning, as to what could be produced, a tremendous amount of fumbling and lost motion ensued. Sometimes a period of ten to twenty years elapsed between the original invention and the final large-scale application.

This might be a very satisfactory method for the proverbial garret inventor who is usually willing to starve most of his life if he can look forward to a few years of prosperity before his death and a luxurious funeral.

Unfortunately and unwittingly, some of our modern research organizations are still believers in the "flashes of genius." Research projects are not selected because their results will fill a present need, but just because some one had an idea which seemed interesting. Often there is no clear conception of what the project will lead to. There are times when research organizations are left at random in the expectation that among the mass of results obtained and carefully recorded, "something useful" will be found—more or less by accident.

Much of the aura of gamble in research is due to this method. If research is to find the place due to it in our economic fabric, it must change its habits. The haphazard search for the miracle must be replaced by planned research, designed to obtain a predetermined result.

I dislike very much the use of the concept "planning" because it has been so badly misused in recent years. At any rate, planning does not necessarily involve charts and detailed programs evolved from scant knowledge.

Planned research should mean the selection of research projects with definite ends in view. If the desired end is a new or improved product to be added to the manufacturer's lines, a tentative set of performance specifications should be set up. This then is the definite goal for the research worker. If it is a process, any desirable improvements over earlier methods should be definitely stated and kept in mind.

A reasonable amount of time and material spent on preliminary tests would show the experienced director or group head just what the difficulties are in the way of the project. Such preliminary test will, as a rule, show definitely whether the project is going to require an endless amount of work and will, therefore, be very costly, or whether it shows signs of being completed with a reasonable expenditure of effort and money.

In fact, I should say that at this point some very rough estimates of the total cost might be in order. It is then possible to weigh the project expenditures against the gains expected. Allowing a goodly percentage for errors, such a calculation should be reasonably accurate.

It is understood, of course, that in some cases the decisions will be wrong. Further sums of money should be appropriated for projects which would take longer than had been expected. For a long period of time and a number of projects, this method will, however, show excellent results.

This method disposes of a great deal of uncertainty in the planning of a research department's tasks. There still remains the adverse time factor to be dealt with.

So long as we speak of five to ten years as a reasonable period for the completion of the average research project, research is going to remain a gamble to those people who have to do the financial planning. No one is willing to look that far into the future.

There is, however, a way to shorten this period to a reasonable period of a year and a half or two years, except for some particularly difficult projects:

After the results of the preliminary tests are in and the decision to finish the project is made, it is profitable to

assign as many workers to the project as can be reasonably used on it.

Very often a project is started with one man. As results are tabulated and show various avenues of solution of the problem, more men are detailed to it. Toward the end, when results are certain, as many as a dozen men can be used to excellent purpose on a single project.

When a project gets to this point, the sums for it should be appropriated as fast as can be economically employed. In other words, money and men are to be fed to a project, not according to a predetermined schedule, but as fast as the project requires them. This process will result in a tremendous speeding up of results and, in the end, a considerable economy in overhead items.

In conclusion, let it be said that during the period of trial and trouble between the two wars the economic emphasis had been on sales and publicity and not on research and development. In the era now dawning, the research department will attain the position it deserves in our industrial organizations only if its leaders show sufficient courage to be willing to stand up for their opinions. They should be willing to make some predictions as to the cost and results obtainable and also to firmly decline projects which do not promise results in keeping with the efforts and expenditures required.

INSTRUMENTS ON THE MARCH

Oil Exploration from the Air Made Possible by Airborne Magnetometer

PITTSBURGH, Penna.—A new era of oil exploration, in which the underground structure of the earth's most inaccessible ocean, jungle, and mountain regions may be "mapped" from the air, has been ushered in by Gulf Oil Corp. The new development—transformed during the war into a secret weapon for defeating enemy submarines—will tremendously speed up discovery of the world's remaining uncharted oil resources.

The airborne magnetometer represents the first practical means of oil surveying from the air; the fastest known means for securing geophysical prospecting data of any kind, and probably the cheapest. It introduces the only means of magnetic prospecting over water.

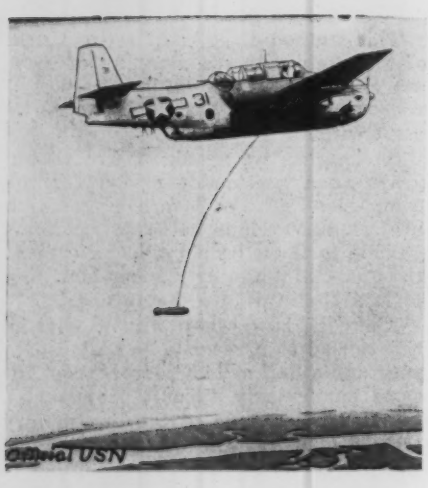
Research on this instrument was begun in Gulf research laboratories in 1940, and a successful test flight made in early 1941. Then fate altered its use from a tool of production to a war weapon. Possibilities for detecting submarines were suggested by its originators to the Government, which granted Gulf a contract to develop this adaptation. The first submarine-hunting model went into operation in the month of Pearl Harbor, 1941.

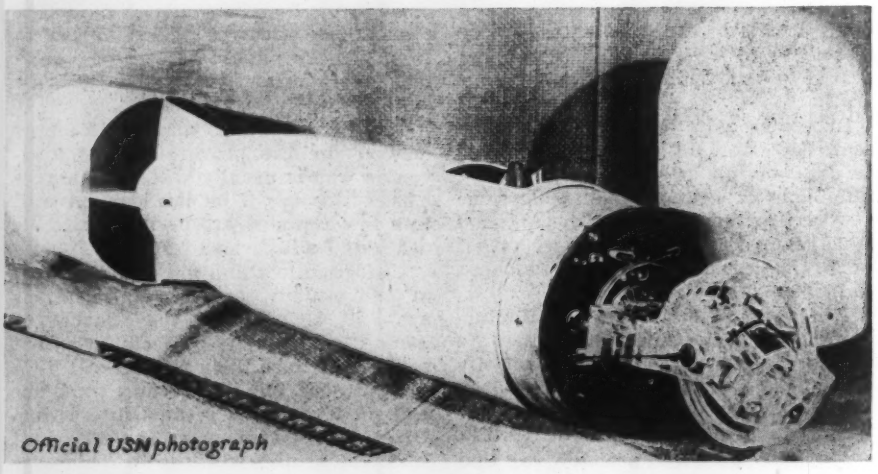
Airborne magnetometers were also developed jointly by the Naval Ordnance Laboratory and the Bell Telephone Laboratories, under the auspices of Navy's Bureau of Ordnance and Bureau of Aeronautics, and by the Airborne Instruments Laboratory of Columbia University's Division of War Research under the auspices of the NDRC. An appreciable number of enemy undersea craft were sunk as a result of "flying eye" detection. The Germans never did learn of this secret nemesis which, unlike any other detector, including radar, could reach down from the skies and "see" under water.

With accuracy as good as—or better than—any similar instrument on the ground, the airborne magnetometer will immeasurably speed up and add to the efficiency of preliminary oil surveying. In a matter of years it may enable the surveying of regions that would require decades by foot expedition. Of all means of geophysical prospecting, it alone provides a continuous record of territory surveyed. It also offers the only means of magnetic mapping over areas where erratic surface magnetic influences make ground readings unusable.

As the only method of magnetic prospecting over water, it opens vast unexplored stretches to the oil geologist.

The present instrument rides in a bomb-like casing (called a "bird") trailed beneath the plane to eliminate magnetic interference. The three photographs are self-explanatory.





Airborne Magnetometer Disclosed

NEW YORK CITY.—A revolutionary device for aerial prospecting for potential oil and mineral producing areas has been developed as an outgrowth of a hitherto secret means of magnetically finding and tracking submerged enemy submarines.

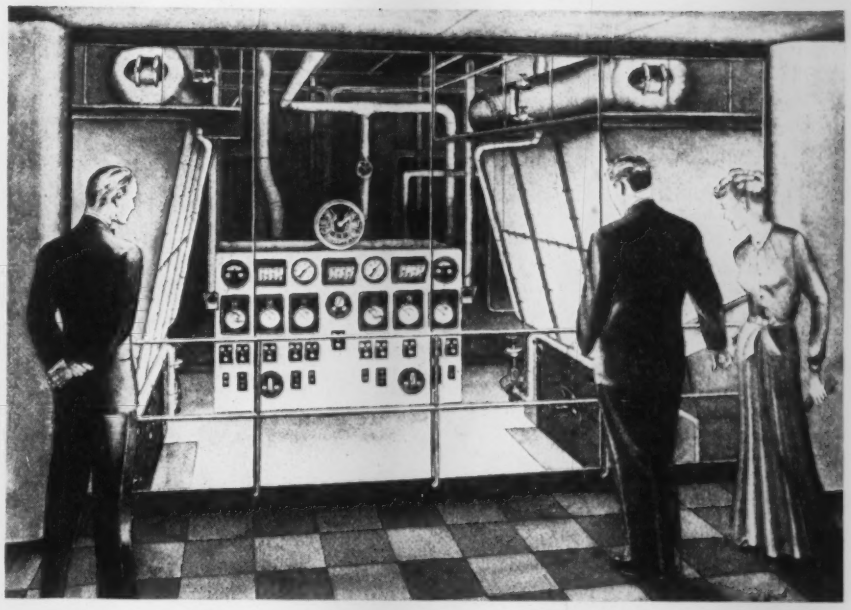
In its wartime role, the airborne magnetometer has been credited with being an important weapon in the crucial struggle against enemy submarines. In its peacetime application, the new device fulfills a long-standing dream of geophysicists in that it provides means for a quick large-scale survey of geological structure which scientists feel may be an important key to our natural resources. It is expected to be especially valuable in such now inaccessible areas as polar regions, jungles and offshore tidewaters.

The device was developed by Bell Telephone Laboratories in coöperation with the Naval Ordnance Laboratory under the auspices of the Navy's Bureau of Ordnance and Bureau of Aeronautics. Other magnetometers were developed by Gulf Research & Development Co., working independently and later under contract with the NDRC; and by Columbia University Division of War Research through its Airborne Instruments Laboratory, also under contract with NDRC.

The method is considered so promising that those in charge of Naval Petroleum Reserves have employed the method extensively in exploring for geological structures which may contain oil. Some 40,000 square miles in this country and Alaska, including part of the latter's Naval Petroleum Reserve area No. 4, have already been mapped. The instrument will also be used by the U. S. Geological Survey in mapping national resources.

Just how sensitive the device is can be appreciated from the fact that during the research a new employee of Bell Telephone Laboratories inadvertently caused considerable confusion when she neglected to mention that a small bit of an ordinary sewing needle which had broken off in her finger some years before had never been removed.

For its peacetime role, the Bell Laboratories-Naval Ordnance magnetometer was revised somewhat and combined with Shoran, a radar mapping device developed during the war, and special mapping cameras under the direction of Dr. L. H. Rumbaugh, chief of the research department of the Naval Ordnance Laboratory. Geophysical applications have developed from plans worked out jointly by Dr. Rumbaugh and J. R. Balsley, Jr., of the U. S. Geological Survey of the Department of the Interior. Research and development work at Bell Telephone Laboratories was under direction of W. J. Shackelton, E. P. Felch and W. J. Means.

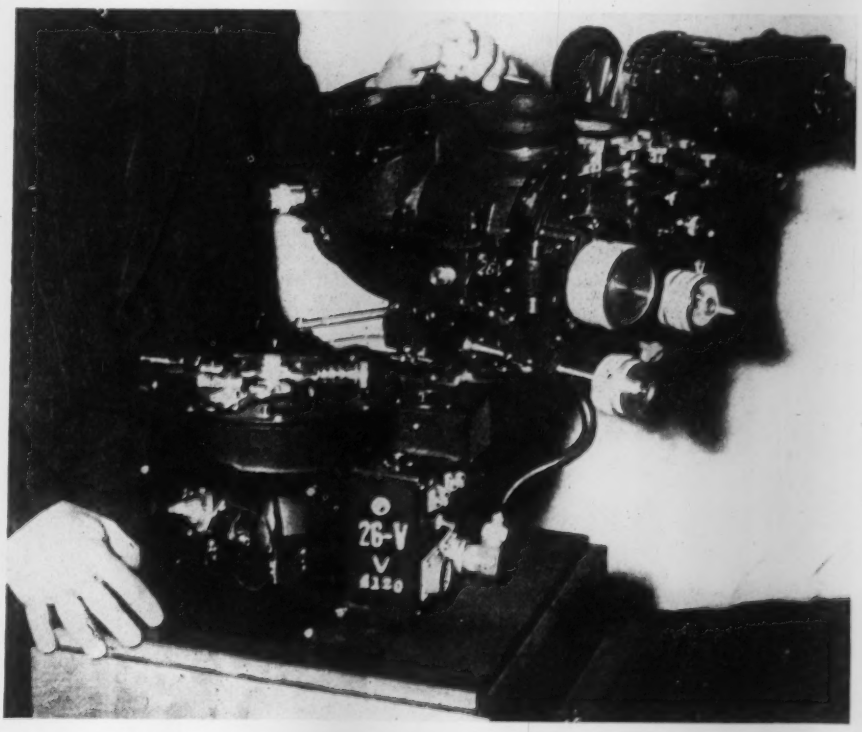


Instrument Company Visualizes "Black Hole" Glorified by Instrumentation in Ocean Liners

CLEVELAND, Ohio.—The role of instrumentation (measurement and automatic control) in bettering working conditions as well as in controlling operating conditions, so often preached by advocates of the modern science of Instrumentation, is strikingly brought out in a drawing released by the Bailey Meter Company of this city. This drawing represents the company's visualization of future control arrangements for passenger liners: it illustrates a glassed-in promenade passageway from which the ship's passengers can view the clean fire-room and the automatic-control panel for the steam plant.

Bombsight Used at Hiroshima

CHICAGO.—Now released from secrecy, this photograph shows the bombsight which directed the first atom bombing in history, with Hiroshima as the target. Known as "Victor No. 4120," the instrument was returned recently to the Victor Adding Machine Co., Chicago, which manufactured $60,000,000 in bombsights for the AAF. Victor engineers developed an altitude attachment that enabled bombardiers to bomb accurately from a height of 50,000 feet.



"Moon Radar" Details Disclosed by Company which Designed and Built It

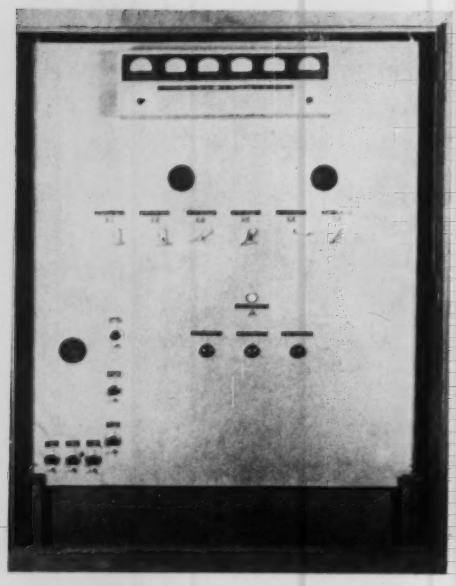


Fig. 1

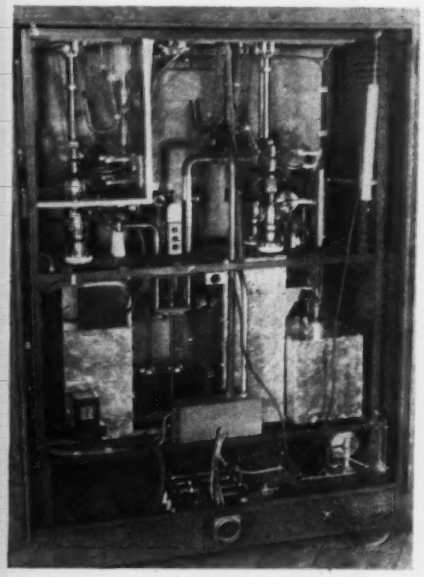


Fig. 2

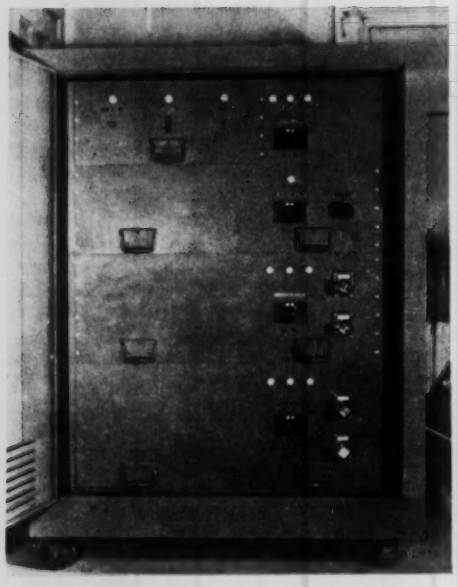


Fig. 3

Fig. 4

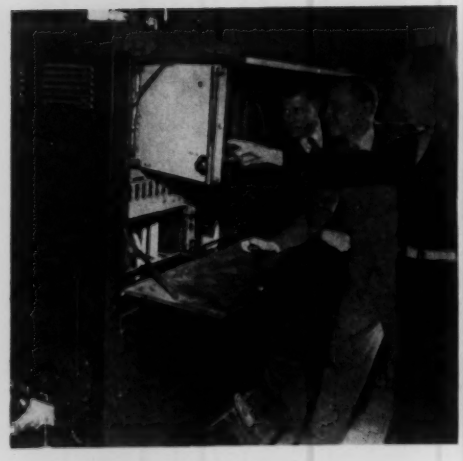


Fig. 5

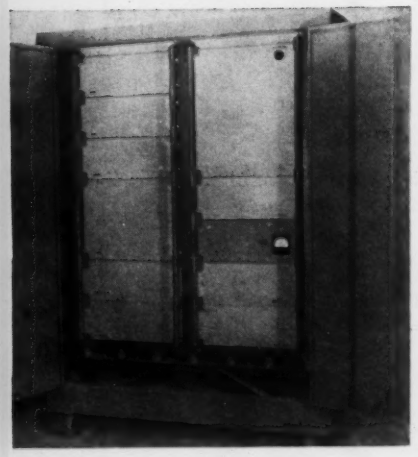


Fig. 6

FLUSHING, N. Y.—Details of the "moon radar" have been disclosed by N. L. Harvey, Supervisor of Circuits Research, Sylvania Electric Products Inc. He said that it was in 1944 that at the request of the U. S. Army Signal Corps a small group of Sylvania Research engineers worked intensively at the design, construction, and testing of a special radar system. Signal Corps engineers under Lt. Col. John DeWitt, Jr., made many modifications but the Sylvania-built radar was still the basic unit used in the moon-contact experiment.

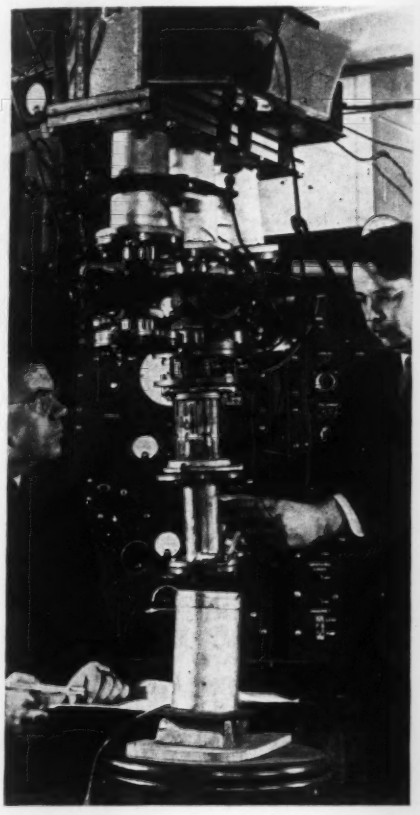
The equipment, built by Sylvania, is housed in three weather-proof cabinets, each about the size of a large upright piano. One contains the transmitter. A front view is shown in Fig. 1. The interior, viewed through the opened rear door, is shown in Fig. 2. Chain and sprocket drives are used for tuning adjustments with controls conveniently located on the panel. Instruments are mounted in a shielded box, and are well by-passed for RF. Viewing windows are provided adjacent to the tubes of the two final stages.

The second cabinet houses the power supplies for the transmitter. Front and rear views of this cabinet with the doors open are shown in Fig. 3 and Fig. 4. The supplies are mounted on base and front panels so they will slide into the angle iron frame in a drawer type of arrangement. The three lower drawers are each taken up by the plate supply for one of the three final transmitter stages. The top drawer space is partly occupied by one drawer, and by the main line switch and circuit breaker. This top drawer contains the plate supply for the first transmitter stage, and the bias supplies.

The third cabinet houses the receiver console. The special door arrangement at the front shown in Fig. 5 is made to provide a table surface at the operating position. Full rear doors, shown in Fig. 6, provide full access for removal of the inner framework which is made so that two vertical rows of panel-mounted equipment can be supported both in the front and in the rear. A sheet of 16 gage aluminum separates and shields the front units from those in the rear. One section at the front of the framework is hinged so that in operation it is swung out to provide a sloping panel for operator convenience. Each chassis is connected electrically to other portions of the system through a multiple connector carrying three coaxial terminals and seven single-contact terminals. All inter-chassis wiring is done in wiring channels at either end of the framework. A special panel and chassis mounting mechanism was designed to provide maximum accessibility. The panel support consists of a handle-like assembly at either end of the panel, which also serves as a hinge.

Atom-smashing Instrument Specialist Heads NBS

PITTSBURGH.—Dr. Edward U. Condon, associate director of the Westinghouse Research Laboratories and vice president of the American Physical Society, who has long been a leading figure in nuclear and atomic research, has been appointed Director of the National Bureau of Standards. For several years he has been engaged in secret Government research activities. The photograph herewith shows him (left) and



Dr. Jerald E. Hill, research physicist, at the target end of the Westinghouse 90-ton atom-smasher. Early discoveries made on this first industrial atom-smasher, built in 1937, contributed to the store of knowledge which made the atomic bomb possible.

One of the important discoveries made with the aid of this 65-foot-high instrument was photo-fission—the splitting of uranium atoms by high-energy gamma rays. Now, preparing for a broad, long-range program of research into the problems associated with putting the atom to useful work, Westinghouse is reconditioning and modernizing this atom-smashing instrument. Dr. W. E. Shoupp is now in charge of the atomic research program at Westinghouse.

In a recent utterance, Dr. Condon sounded a warning against the development of a "Maginot Line mentality" of smug complacency because we have created the world's deadliest weapon from the atom. "I am not advocating that we should freely tell all of the technical results of our program," he said. "I am, however, making the point that we cannot assume that we shall have the military advantage of exclusive possession of this weapon for more than a few years. We must not develop a Maginot Line mentality in which the atomic bomb is our Maginot Line.

"It cost us two billion dollars to do the job the way in which we did it, . . . with emphasis on speed and without regard to cost. There may be vastly simpler ways of doing this than we have used. . . . It is conceivable, for example, that in the years to come some small group of Nazi scientists working in some remote haven, say in South America or perhaps in Spain, may find a way to do this thing with only small, inexpensive and inconspicuous equipment. That is one of the most important reasons why we must continue the most careful and thorough investigation of atomic physics and why we must set up a world order that really covers the entire world—one which does not leave us unaware of what is going on in any remote valley in Spain. With this power in man's hands, world coöperation must come. It is peace or death."

Dr. Condon, an outstanding figure in the field of modern theoretical physics, is widely known for his work with radioactive materials.

Born in 1902 in Alamogordo, N. M., where 43 years later the first atomic bomb was exploded, he worked for several years as a newspaper reporter in the San Francisco Bay region after graduation from high school. In 1921 he entered the University of California, from which he was graduated with highest honors in physics in 1924. Two years later he received his doctorate in physics from the same institution.

Dr. Condon studied for a year in Gottingen and Munich as a National Research Fellow and then returned to this country to teach at Columbia, Princeton and the University of Minnesota. He joined the Westinghouse research staff in 1937.

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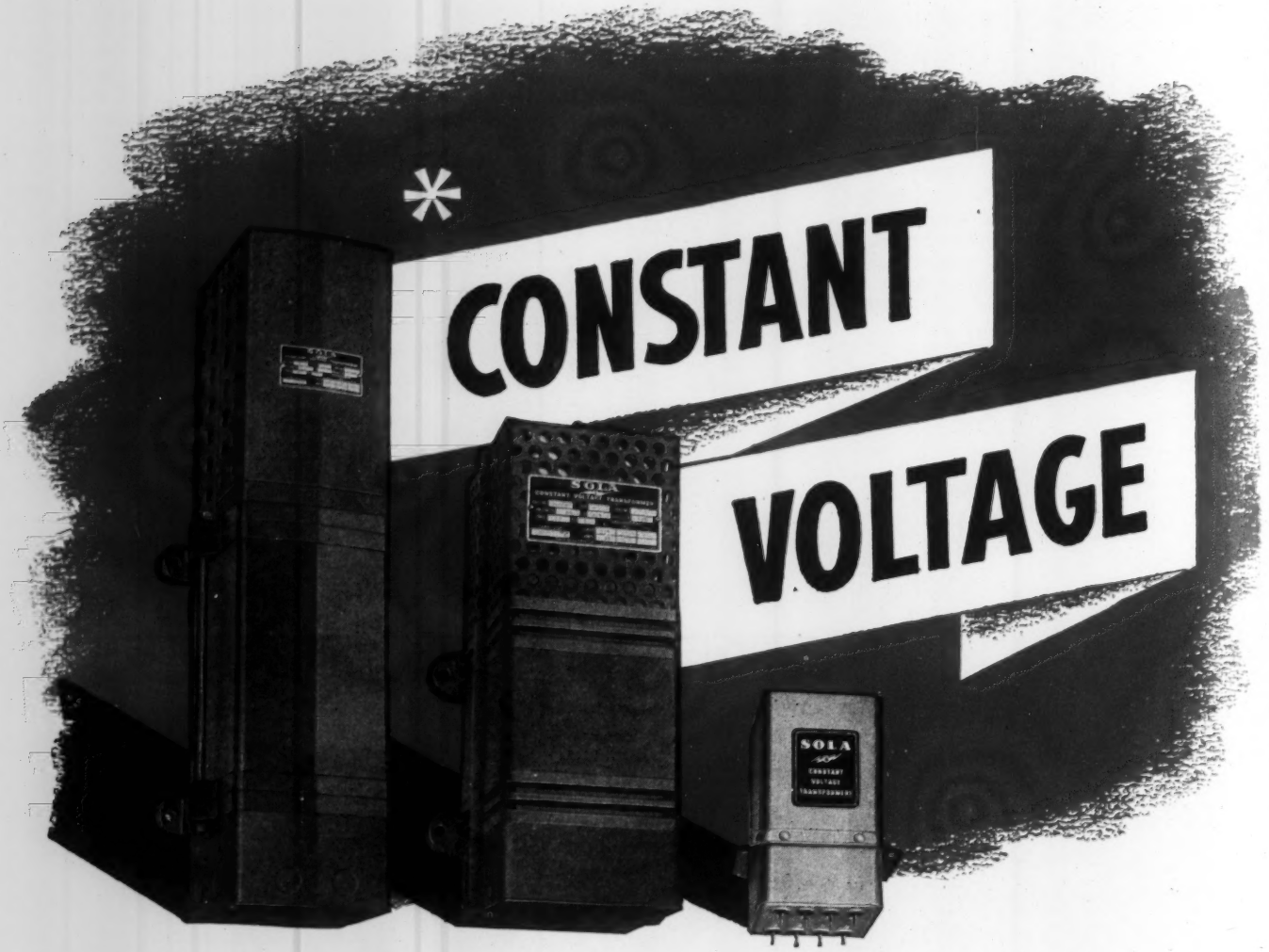

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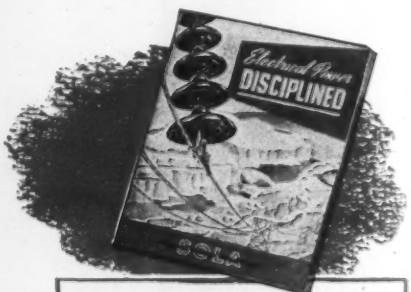

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Ask for Bulletin GCV-102

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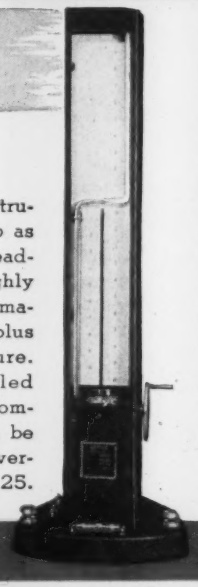
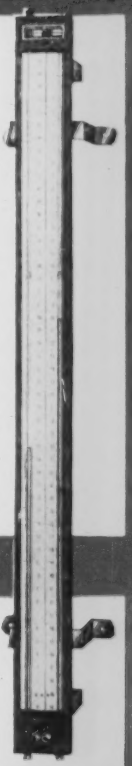
Recent additions to the MERIAM "Family"

Micromanometer



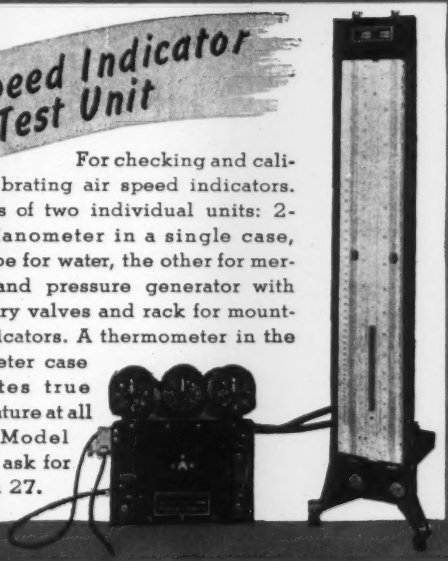
For calibrating low pressure instruments and other devices, also as a conventional manometer for reading pressures or vacuums. Highly sensitive, the Meriam Micromanometer permits readings to plus or minus .001" water pressure. Most rugged, and unequalled in simplicity. Not the least complicated or mysterious, it can be handled successfully by the average operator. Ask for Bulletin 25.

Dual-Tube Manometer



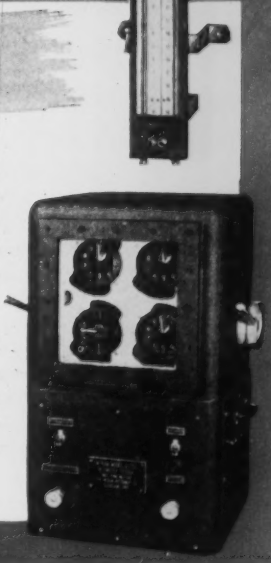
Ideal as a calibrating standard manometer for checking flow meters, pressure gauges, and other secondary units operating on pressure or vacuum principle. Consists of two separate manometer tubes in the same case—each tube with individual well. The left tube has a scale increasing upward; the right tube a scale increasing downward. Both tubes are connected in parallel to the same pressure source. Ask for Catalog Sheet M-100WM.

Air Speed Indicator Test Unit



For checking and calibrating air speed indicators. Consists of two individual units: 2-tube Manometer in a single case, (one tube for water, the other for mercury); and pressure generator with necessary valves and rack for mounting indicators. A thermometer in the Manometer case indicates true temperature at all times. Model A-921; ask for Bulletin 27.

Altimeter Test Unit



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IX. PRODUCTION OF HIGH VACUUM *(Continued)*

Single-jet Mercury Vapor Pumps

A small single-jet mercury vapor pump is illustrated in Fig. 105. For convenience in building the pump, the respective fabricated parts are shown in Fig. 106. The pump is assembled as follows:

1. The inner condenser jacket, part B, is put into part A and the flare of the inverted seal is sealed to the wide end of part A. The tube extending beyond the flare seal is then fused and a round bulb is blown. The flare seal is kept hot while the bulb is blown. The tube is then opened at the top of the bulb and a small flare is retained around the opening so that a ring seal can be made between the bulb and the outer edge of the shoulder of part C. This ring seal is made and tube D is sealed to the jacket at the flare seal. Tube E is then sealed to the bulb. The entire end of the pump is then carefully annealed. After the pump has cooled, the bottom ring seal is made and the side tube D is sealed to the water jacket. The gas outlet tube F is sealed below the ring seal at a 20° angle after the ring seal is annealed. The mercury boiler and vapor tube are then sealed to the pump.

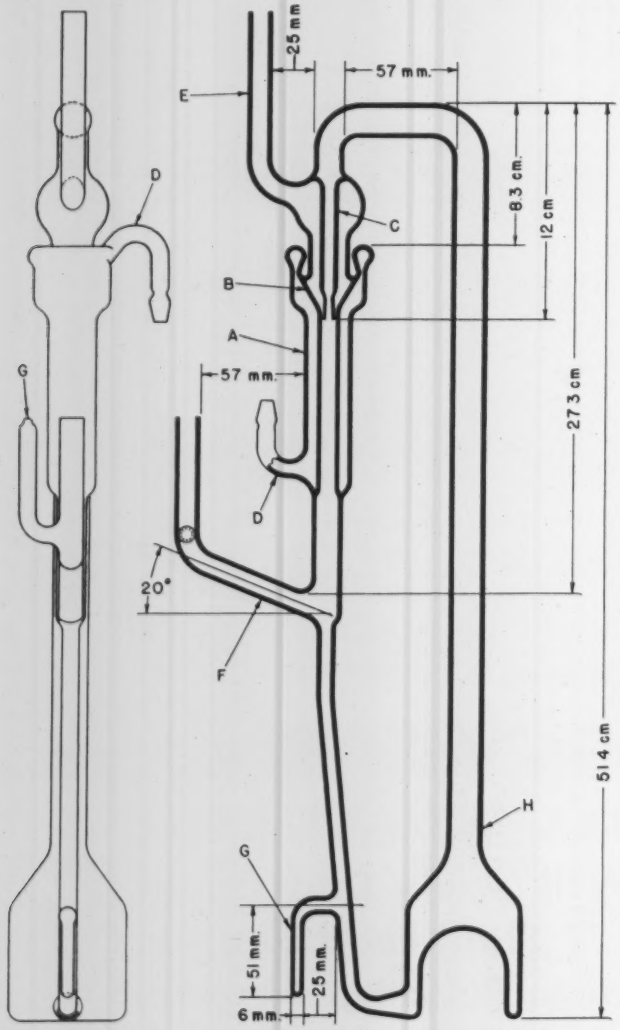


Fig. 105

The small tube G serves as a level indicator for the mercury. It is closed after the required amount of mercury has been added.

A single-jet mercury vapor pump designed by J. E. Shrader and R. G. Sherwood[7] is illustrated in Fig. 107. This pump is simple in design and can readily be made by anyone who has mastered the ring, flare and side-arm seals. The parts for the pump are first fabricated according to the dimensions given in Fig. 108. The pump is assembled as follows:

1. Part B is inserted into part A so that the flare on the latter rests on the shoulder of part B. The glass of the flare and shoulder is sealed and a shoulder is blown below the seal in the glass of part A. The tube below the shoulder is opened with the burner flame and part C inserted into the opening until the shoulder of this part rests against the edge of the opened tube part B. The end of part C should extend 25 cm. into the water jacket. The glass at the juncture of part B and C is then sealed. A shoulder is then blown in part C just below the ring seal and the glass is opened below the shoulder. It is important that the glass be opened at exactly 13.3 cm. below the outer jet of part C. The inner jet, part D, with the inverted ring seal is then inserted into the opening until the flare rests against the open end. The flare seal is completed and the inner jet is

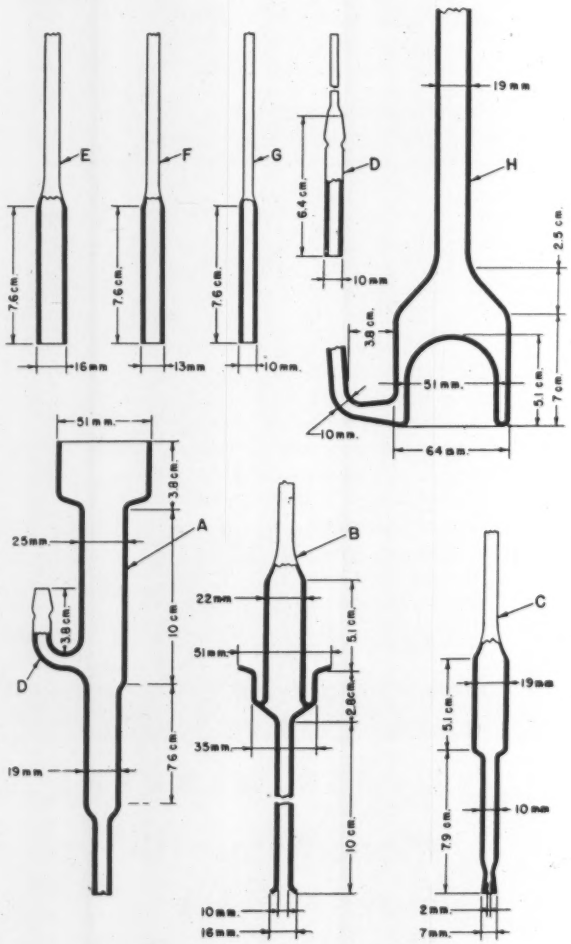
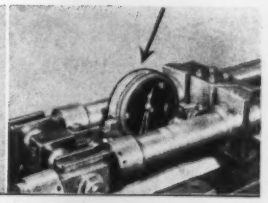


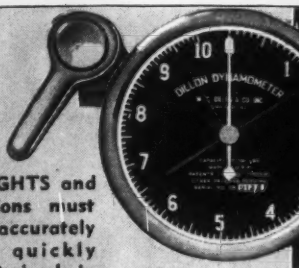
Fig. 106

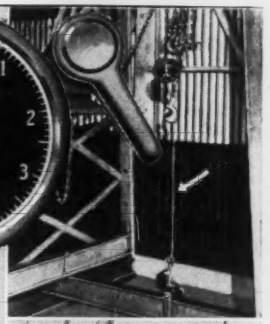
For Every

LOAD OR TENSION



DILLON DYNAMOMETER





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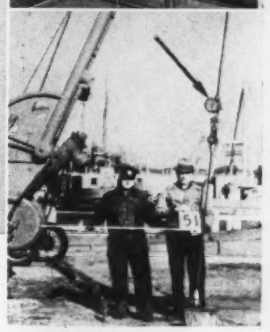

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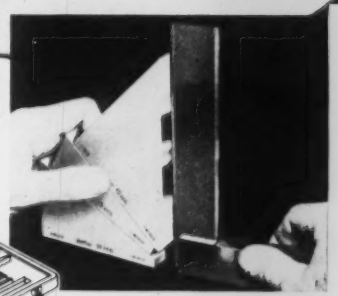

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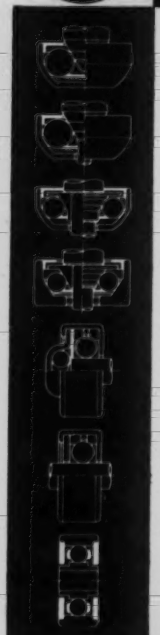

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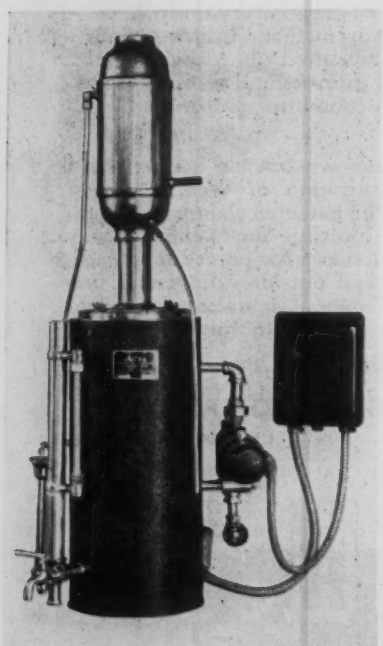

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centered in the pump. As the pump is being assembled as described above, it is extremely important that every seal be kept hot until all side arms are connected. After each ring seal is completed, the preceding seals must be heated so that no preheating will be necessary for making the side-arm seals. The side arms, parts E, F, G and H, are then sealed to the pump in this order. The entire section is then carefully annealed and allowed to cool slowly. After it is cool, the top ring seal is made and the side-arm hose connection, E, is sealed to the outer jacket of the condenser.

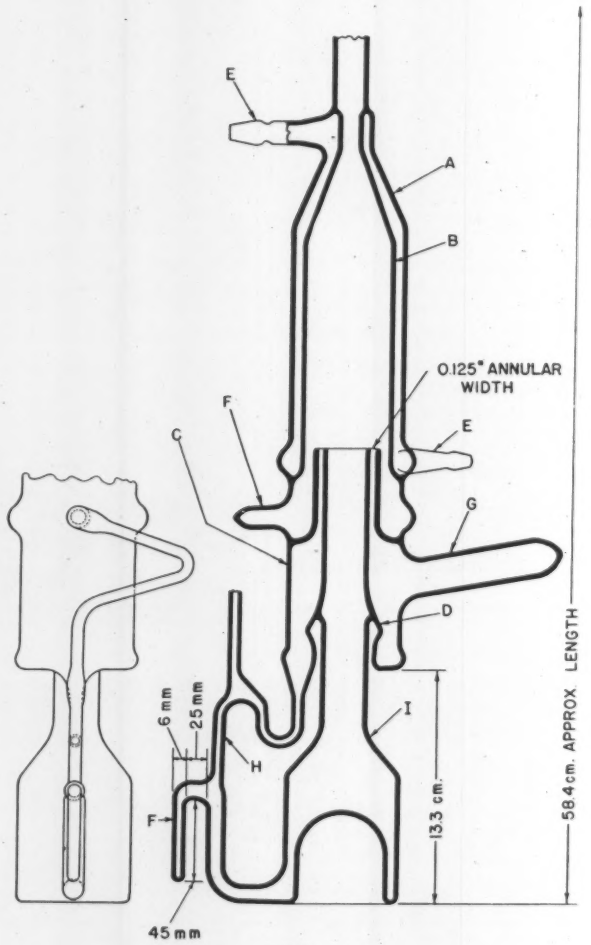

Fig. 107

The end is then annealed. The boiler, I, is sealed to the vapor line. The mercury return lines are sealed to the side arms of the pump and boiler.

A combination of the single-jet and the upright jet pump has been used by one of the authors for evacuation of vacuum jackets. The inlet of the single-jet pump is connected to the outlet of the upright jet pump. A rotary pump is used for producing a forepressure for the single jet pump. In trial runs it has been found that a forepressure as high as 2 mm. was sufficient to give a pressure of 10^{-5} mm. mercury on the high vacuum side of the upright jet pump. With a good backing pump, the combination will produce vacua of the order of 10^{-6} mm. of mercury.

Annular Jet Pump

The recommended procedure for preventing the diffusion of mercury vapor into the system which is being evacuated is to use a trap which is surrounded by a refrigerant as liquid air. The conventional traps as illustrated in Fig. 119 are quite efficient in trapping the mercury vapor, but they reduce the effective speed of the condensation pump. Two alternatives are apparent for reducing the back diffusion of mercury vapor:

1. The amount of mercury vapor which diffuses back into

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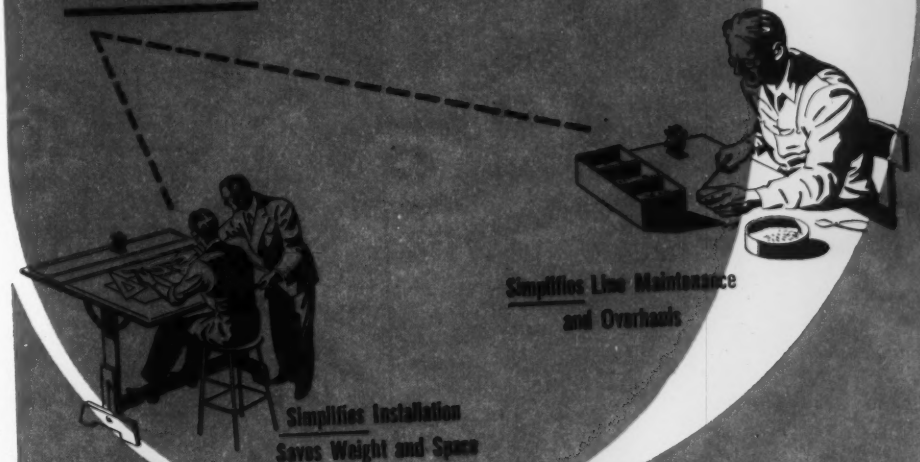

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the vacuum system can be reduced by more efficient water condensers in the condensation pump.

2. The speed of the condensation pump can be maintained by the use of traps which offer less obstruction to the flow of gases being pumped from a system and yet condense all mercury vapors.

An annular jet pump designed by C. S. Bull and O. Klemperer[8] is shown in Fig. 109. The mercury vapor produced in a conventional boiler enters the pump jet through a large vapor line. The jet is annular to offer the least resistance to the gas which passes down into the mercury

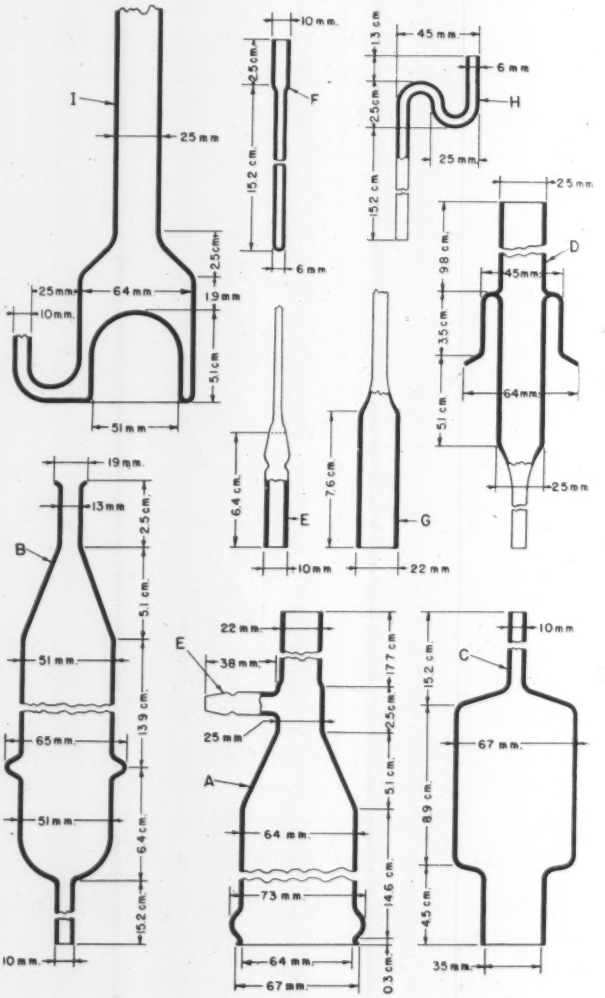

Fig. 108

vapor stream. An inner condenser and an outer condenser give a maximum of condensing surface. The condensed mercury returns to the boiler under gravity flow. The pump assembly has two additional features:

1. A trap is so designed that mercury vapor which diffuses back toward the vacuum system must impinge on a cold surface. The trap can be fabricated from glass or metal which does not amalgamate. Liquid air is kept in the trap and if the cone and baffle are made of metal, this assembly is made to give a close fit in the inverted glass seal which is part of the trap.

2. A metal shutter, which is closed to prevent migration of mercury into a vacuum system when the pump is not in use, is conveniently installed above the trap. The metal surface rests on a glass groove which has been ground flat for close contact between the glass and metal. The shutter is closed by the arrangement illustrated in Fig. 109.

The assembly shown in Fig. 109 was used to measure the speed of the pump which was calculated from the dimen-

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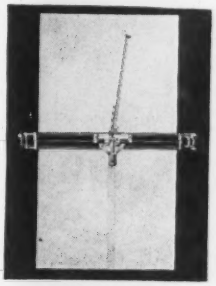

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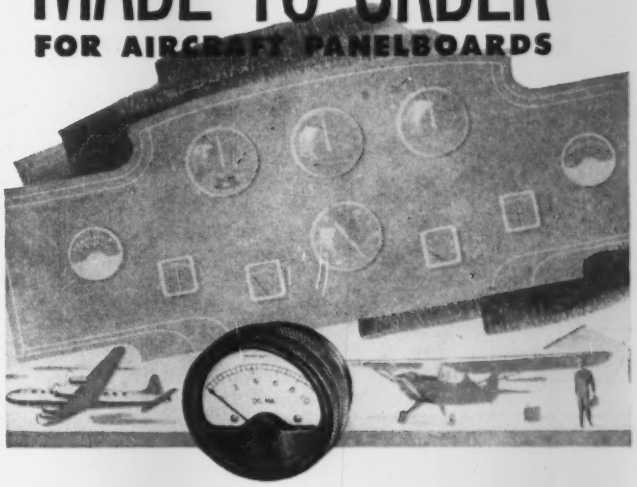

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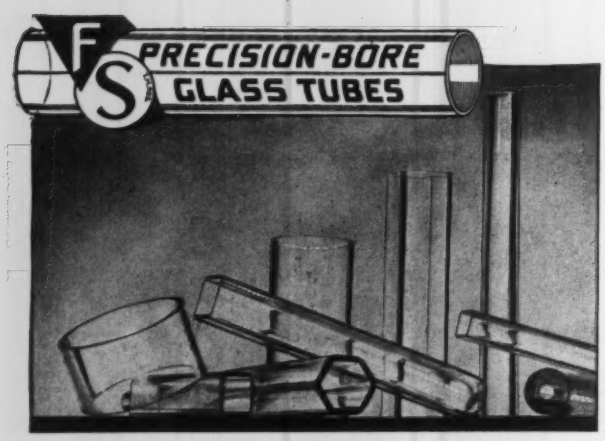

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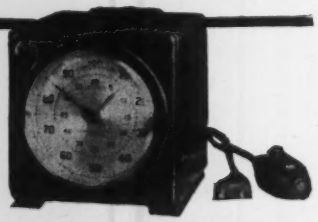

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sions of the capillary and the respective pressures in the reservoirs on the high and low pressure sides of the pump. The speed of the pump was 90 liters per second at a pressure of 5×10^{-5} and 20 liters per second at a pressure of 3×10^{-6} mm. mercury respectively.

Metal Nozzle Mercury Condensation Pump

A mercury condensation pump with a metal nozzle was designed and tested by Estermann and Byck[10]. The pump details are shown in Fig. 110A and the nozzle details are

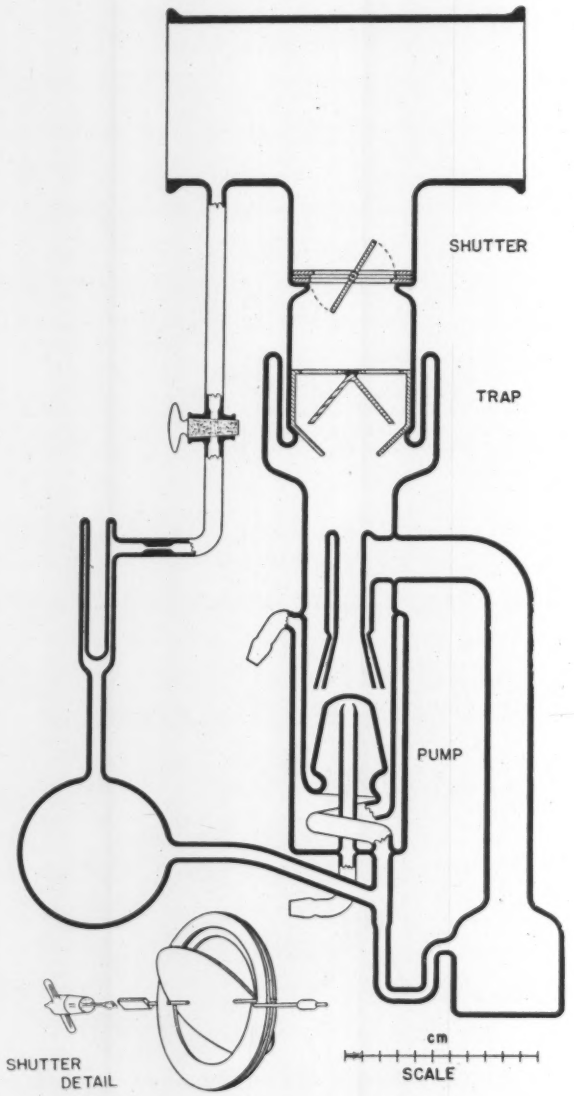

Fig. 109

given in Fig. 110B. The nozzle was made so that various annular areas could be tested by successively machining the inner and outer metal sections of the nozzle. The nozzle was made to give a friction fit over the glass vapor line from the boiler. The pump is simple in design and is made as follows:

1. A 50-mm. tube is flared at both ends. The overall length of this flared tube is 35 cm. The flares should fit into a 70-mm. tube. A 45-cm. section of this tube will be sufficient for the outer jacket. The end of the tubing which contains a size 50 inner member of a ground glass joint is opened for sealing to the reduced section of the outer jacket. Two hose connection side arms are made and a point is drawn on a 30-mm. and a 20-mm. tube, each of which is 15 cm. long. A mercury boiler is made as previously described. The vapor tube of the boiler is 15-mm. tubing. A

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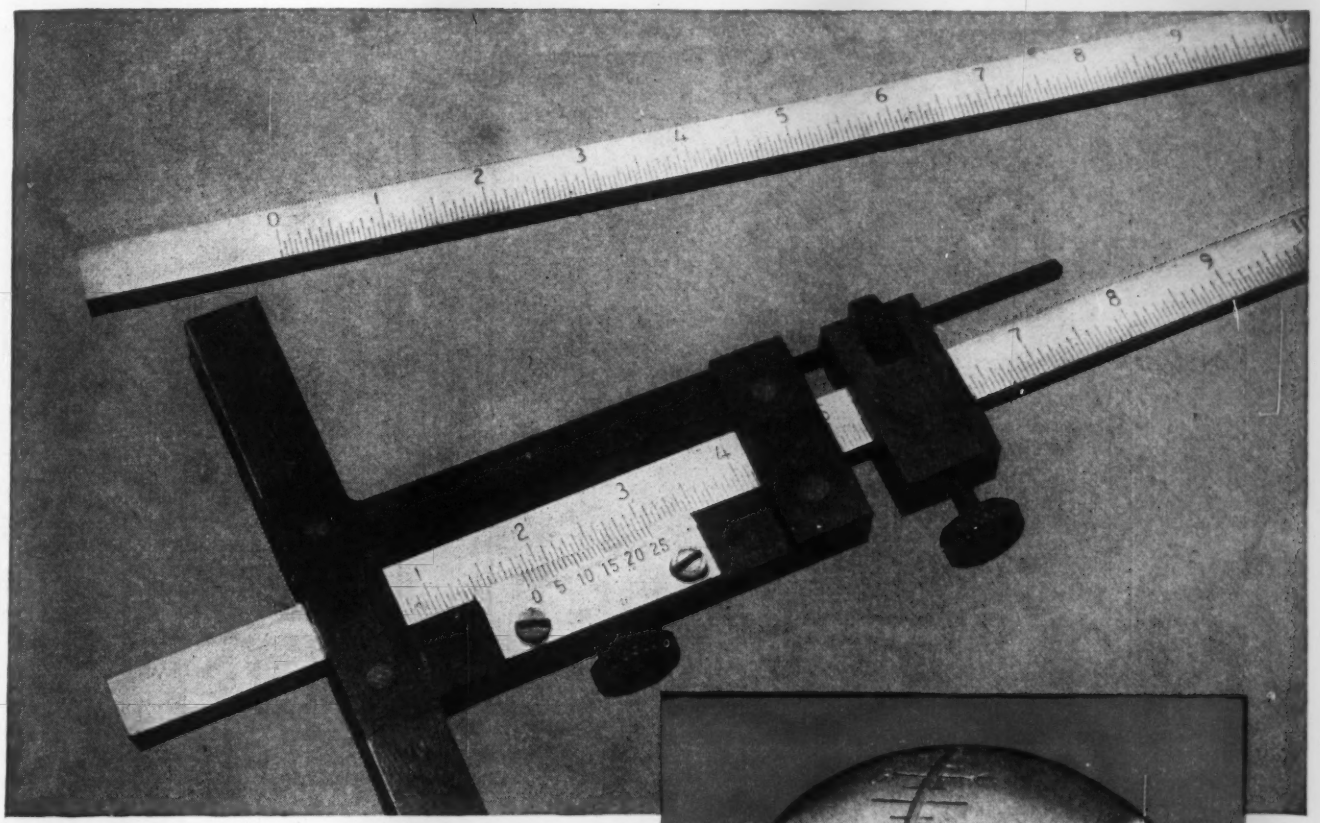

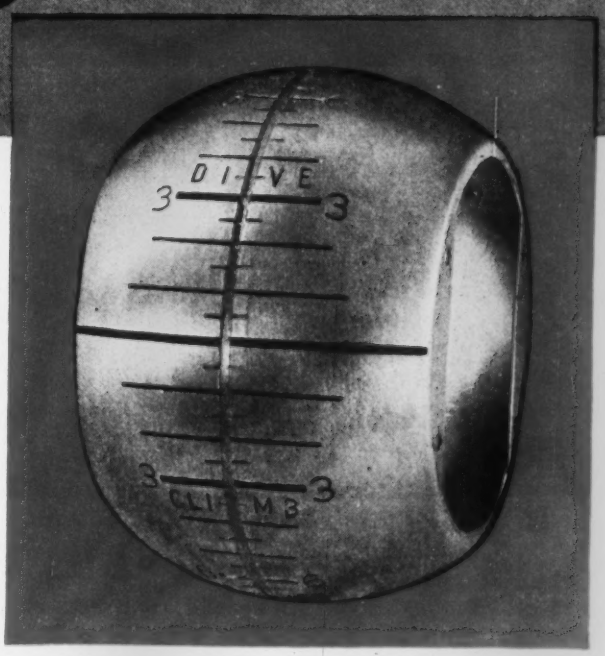

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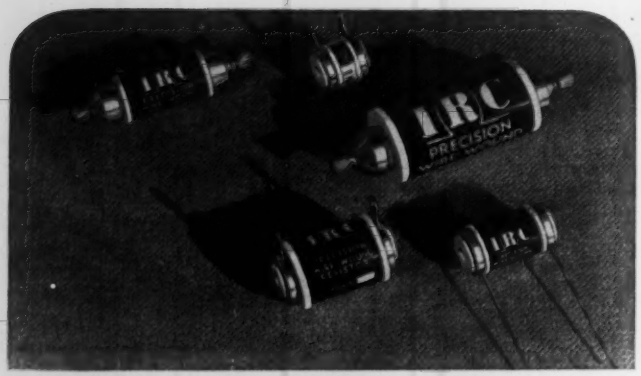

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small shoulder is blown 27 cm. from one end of a 37-cm. length of 15-mm. tubing.

2. The inner jacket is inserted into the outer jacket and one ring seal is made by fusing and working the glass of the outer tube and the flare of the inner tube. The outer jacket is drawn down to the diameter of the tube containing the ground joint. This tube is sealed to the reduced section of the outer jacket and the side arm hose connection is

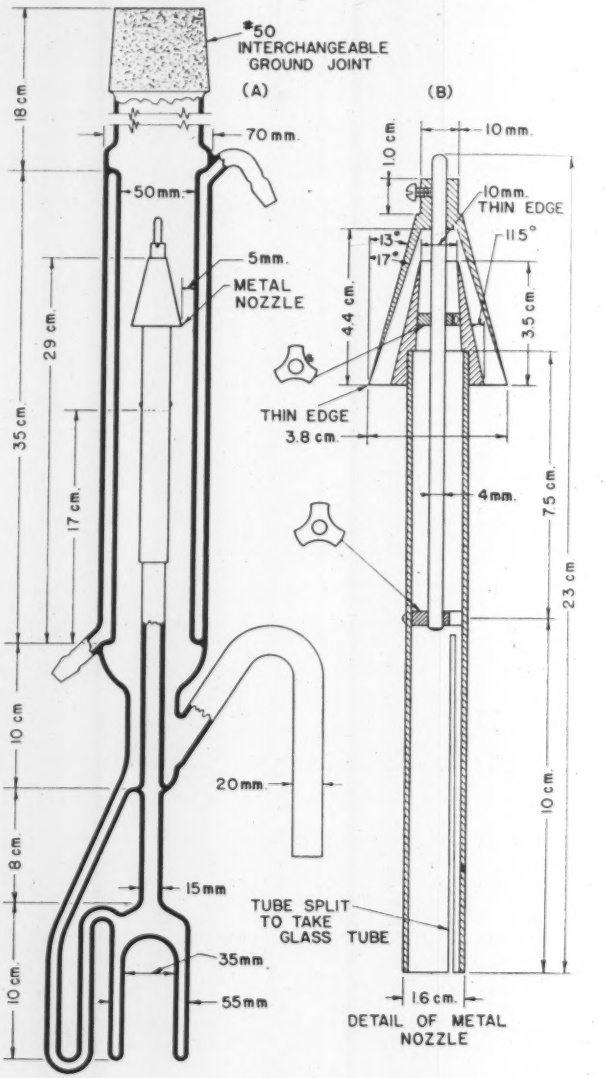


Fig. 110

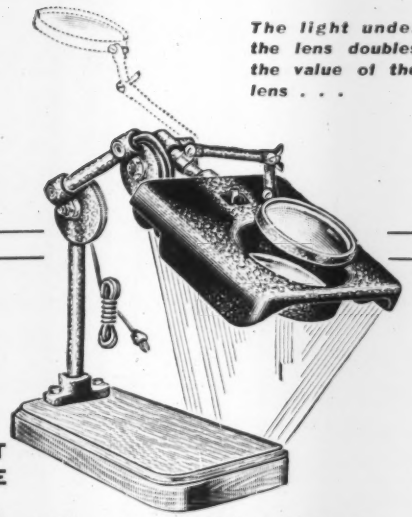
sealed to the outer jacket. The end is then annealed and allowed to cool.

3. The bottom ring seal of the water condenser is then made and the hose connection is sealed to the outer jacket. The tubing below the ring seal is drawn down to 30 mm., opened, and a 30-mm. tube is sealed to the opening and the seals are annealed. The 30-mm. tube is opened to fit the

TABLE 15
PERFORMANCE OF METAL NOZZLE PUMP AT VARIOUS CLEARANCES AND DIFFUSION AREAS

Clearance in cm.	*Area of Diffusion Region in cm.²*	*Pumping Speed of Air in liters per min.*
0.1	1.5	3.0
0.2	2.9	5.0
0.33	4.7	8.5
0.55	7.4	13.0
0.63	8.4	9.5
0.71	9.2	8.4

These tests were made by measuring the pressure at a point 30 cm. from the nozzle, which in practice, is the distance the vacuum system is located from the nozzle.



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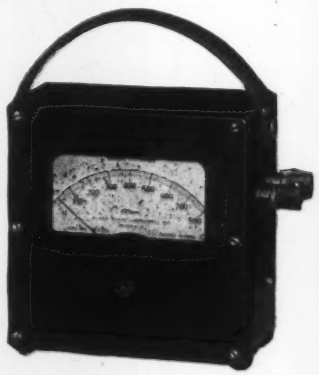

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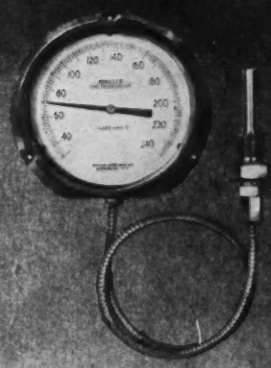

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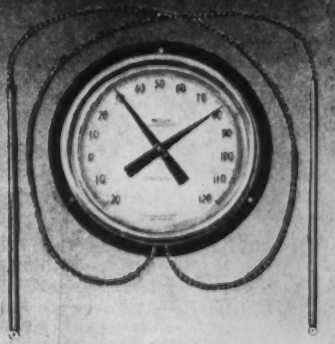

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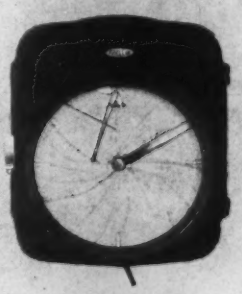

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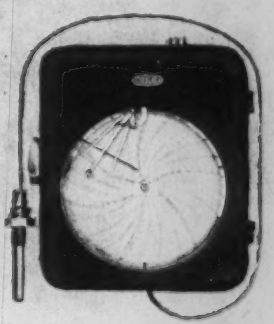

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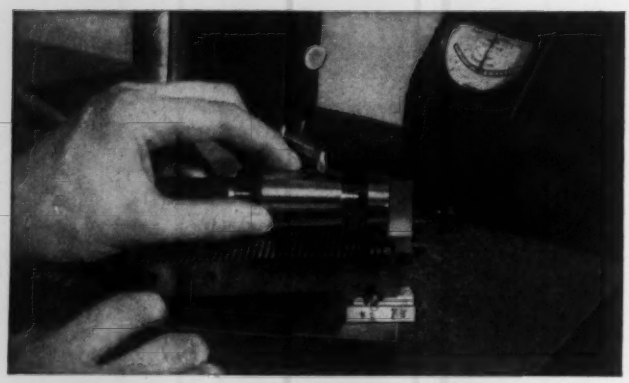

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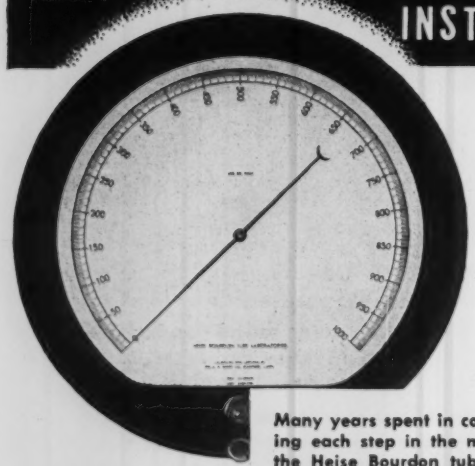

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vapor tube shoulder. The vapor tube is ring-sealed and centered. The mercury return line and pump outlet are sealed to the pump in successive order and the entire end is annealed.

4. The boiler and mercury return lines are then sealed to the pump.

5. The Monel or stainless-steel nozzle is machined as shown and inserted into the pump through the top end. The nozzle tube should fit snugly over the glass vapor line.

Data of tests at various nozzle areas are given in Table 15; the pumping speeds at various clearances and diffusion areas are given in Fig. 111.

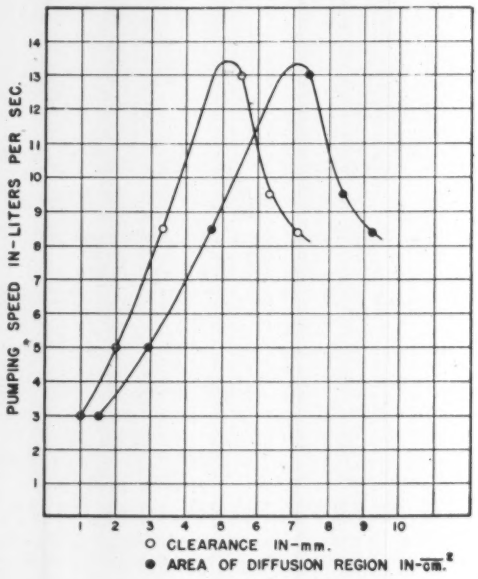

Fig. 111

To be continued

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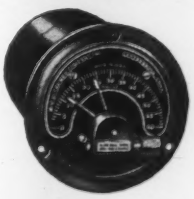

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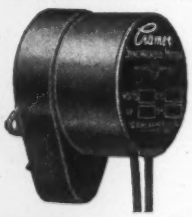

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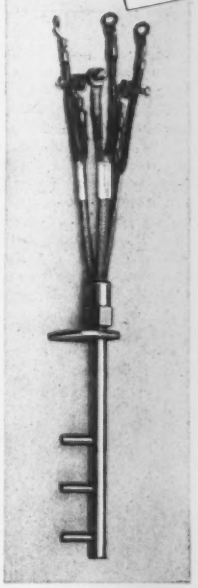

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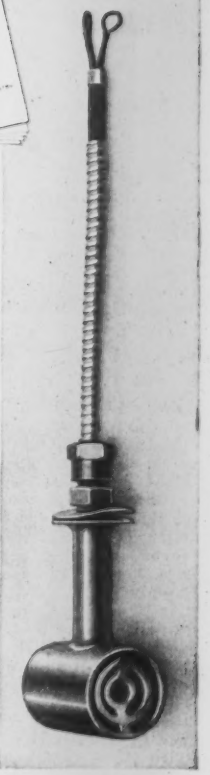

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The Month's NEW INSTRUMENTS

In this department we report each month new devices for measurement, inspection, testing, metering and automatic control—in the form of concise technical descriptions. For further information use the postage-free Order Card on page 575.

Photoelectric Micrometer for Continuous Gaging During Production

New "Visi-Limit Electronic Micrometer" was primarily designed for continuous production measurement of outside diameter of

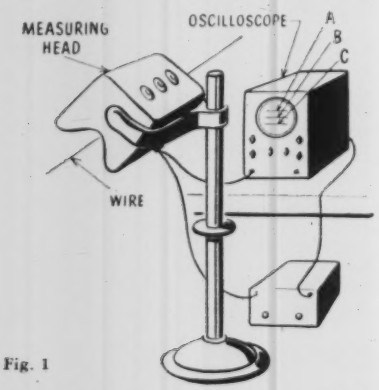

Fig. 1

insulated wire but is suitable for continuous dimensional inspection of many other products. Utilizing a phototube, with light as a measuring medium, it requires no physical contact with measured part, hence is suited to measurement of razor blades, extruded plastic, rubber- or plastic-covered wire, etc. No limitations are imposed upon speed of operation. Components, shown in Fig. 1, are (1) measuring head; (2) power supply unit; (3) oscilloscope. Measuring head contains measuring aperture over which the wire (or other material to be measured) is fed. Aperture is illuminated by a projection lamp which casts a shadow of object being measured on cathode of a phototube located behind measuring aperture. Area on surface of cathode which is not in a shadow produces a voltage signal. Two other apertures (see Fig. 2) are separately adjustable to represent the positive and negative tolerance limits. A scanning disk rotates between apertures and phototube, so that three voltage pedestals are fed to amplifier circuit, in a time sequence synchronized with disk rotation. At points in this cycle where scanning disk changes from one aperture to another, particular care in design is taken so that total area uncovered at any one time is constant. Several important features result: (1) Phototube voltage signal is a.c. in character and allows the use of a-c. amplification; (2) signal level changes only in proportion to tolerance and does not change with respect to absolute dimension of material; (3) sensitivity of instrument is not dependent on size of material. For instance: it is possible to measure a dimension of 0.6" or 0.005" within accuracy of ±0.0002". Each of the three voltage pedestals is amplified in a common amplifier circuit, is then applied to vertical deflection plates of oscilloscope. Sweep voltage is applied to horizontal plates in such manner that termination of each viewing cycle occurs at time that scanning disk alternates from one aperture to another. Thus each of these three voltage pedestals appears as a horizontal line on oscilloscope screen; all three lines appear as simultaneous and continuous traces. When size of material under measurement changes, voltage signal represented by test trace varies proportionately, causing test trace to change its position relative to the two limit traces. (Limit traces maintain their relative positions exactly as they have been adjusted for a given production run.) Thus, operator of the production machine on which "Visi-Limit" is installed has before him a continuous visual check. When variations in dimension of product are noted, operator can quickly adjust production equipment. *Stability features:* Voltage variations which normally cause fluctuation of scope pattern cause no error, as all three traces move together. Gain variations in

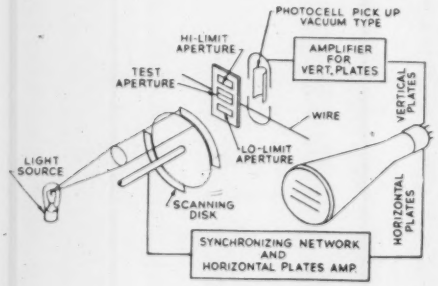

Fig.2

scope or amplifier circuits cancel out, as all three signals are amplified in the same channel. Use of a single phototube eliminates errors due to fatigue, temperature change, etc. Vibrations of material being measured do not cause measurement error: vibration in horizontal plane merely changes position of shadow and does not change its size; effect of vibration in vertical plane is minimized by use of parallel light. It is possible to mount equipment within 4" of a given extrusion head, or other support, obviating need of using rollers or other supports on measuring head. A positive air pressure is maintained within measuring head to prevent accumulation of dust in apertures. Initial set-up of the micrometer for a production run consists simply in adjusting calibrated test aperture with aid of a reference standard of known dimension, and adjusting limit aperatures for tolerance. *Size Ranges:* 0.005" to 0.6" for standard "Model P56" and 0.6" to 1.0" for special "Model P56-1." Adaptations can be made to accommodate particular items of various sizes.—*Raymond M. Wilmotte, Inc., 236 West 55th St., New York 19, N. Y.*

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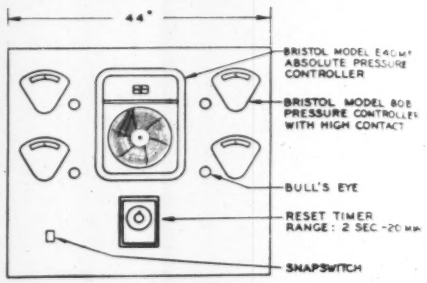
Automatic Control for Evacuation and Gassing Packages

New complete system is announced for automatically controlling evacuation and gassing of food products packages in multiple-unit gassing machines. This process consists of subjecting unsealed cans or other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BRISTOL MODEL 64GM ABSOLUTE PRESSURE CONTROLLER
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BULL'S EYE
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packages to a high vacuum and then introducing an inert gas such as nitrogen under pressure before packages are sealed. Automatic-control system is designed so that a bank of two or more machines can be handled by one set of operators who merely load and unload retorts in any order: as each is closed and sealed, operator pushes a start button and moves on to next machine. Control equipment takes over and processes each batch as soon as preceding one has completed its cycle. Automatic-control equipment consists of a retort selector, a timer and an absolute pressure gage with low-pressure adjustable contacts. In addition, two relays, two control valves, and an indicating pressure controller are required for each machine. Spare contacts on retort selector allow for addition of extra machines.—*The Bristol Company, Waterbury 91, Conn.*

Please mention number **902** when filling out card

Portable Audiometer

New "6 BP Audiometer" is for use by physicians and hearing aid dealers in the office and for outside calls. Circuit features of its table model predecessor ("6B") have been retained, but design for new portable unit provides greater utility, convenience, and ease of operation, which also makes it preferable for schools and hospitals. Face prove readability of frequency and volume plate of set its tilted backward 18° to imcontrol dials. Front edge of chassis has been raised about 2", permitting introduction of a sub-panel below edge of chassis, utilized for mounting jacks for air and bone-conduction receivers, a switch for selecting receiver for any particular test, and an indicating lamp that lights when set is in operation. Power cord is also brought out through this sub-panel. Cord and push-button test tone indicator of former models, used by patient to indicate whether or not he had heard the tone, has been eliminated. Instead, patient holds his index finger up as long as he hears the tone and lowers it when he fails to hear. This simplifies tests, particularly for school children, without decreasing effectiveness of set. Other modifications and features include two vents in side of carrying case to carry away heat generated in tubes and other elements. Two

storage compartments, on inside of removable cover, hold the receivers, cords, index rings, and audiogram charts. — *Western Electric Co., 195 Broadway, New York 7, N. Y.*

Please mention number 903 when filling out card

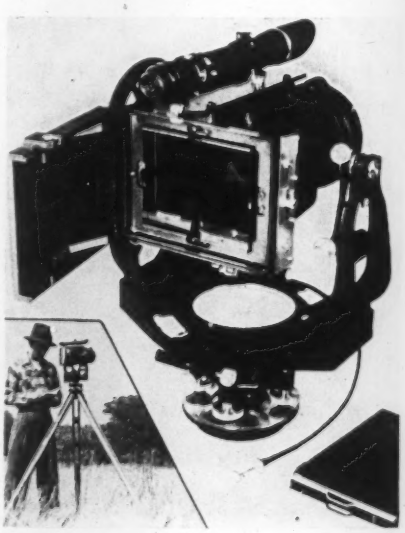
Operation-time Attachment for Recorders and Controllers

New operation recording attachment is for maker's rectangular-case instruments unit for recording and controlling pressure and temperature in industrial processing, where it is often desirable to have a record of the time during which a given piece of equipment is in operation. Auxiliary pen unit is said to be simple in design and operation. Actuating element is a bimetallic strip through which a current passes whenever power circuit to pump, compressor, or other equipment is energized. Current (3.5 amp. maximum) causes strip to heat and consequently to warp. Strip's bending moves pen, which moves about 3/16" inward from outer edge of chart, producing record. About 10 seconds is required from instant warp switch is energized until pen is in proper recording position. Within 30 seconds after deenergizing, pen returns to outer edge of chart. This unaccelerated pen action prevents ink splashing.—*Brown Instrument Co., 4482 Wayne Ave., Philadelphia 44, Penna.*

Please mention number 904 when filling out card

Camera-transit

New combination of special camera and surveyor's transit, believed to be the first American-manufactured camera transit, was developed by maker's engineers in cooperation with J. E. King of U. S. Forestry Service to meet specifications of U. S. Navy Hydrographic Office. Unit consists of a "Type 5078-E" K. & E. transit combined with a 4"×5" plate camera. To provide sufficient mounting space for camera, a wide aluminum base plate, fitted around base of compass box and fastened to upper limb of transit, permits standards to be separated so that camera can be mounted between them on axis normally occupied by telescope. Telescope is mounted on top of camera with its optical axis parallel with that of camera. Camera is made of aluminum alloys to minimize weight, is equipped with an 8¼" *f*6.8 Goerz Aerotar lens, provides 4" × 5" negatives on glass plates, contains fiducial marks in focal plane which are adjusted by National Bureau of Standards to locate principal point of the photograph within specified accuracy. Camera back holds glass plate holder in such a way that plates are pressed against fiducial marks to give maximum precision in the photograph. A level bubble within camera is photographed on each negative, as a check that transit was leveled properly when picture was taken. A counter also is registered on negative to identify any one of the 12 photographs taken at a given station. Station number and focal length of camera are also recorded on each photograph. Camera has a Wollensak No. 4 shutter, with speeds of 1/50, 1/25, 1/10, 1/5, and 1/2 second, or for time and bulb exposure. Diaphragm stop range is *f*6.8 to *f*32. Accessory equipment includes three filters (red, yellow, minus blue), carrying case, and plate holder box for seven glass plate holders.—*Fairchild Camera & Instrument Corp., 88-06 Van Wyck Blvd., Jamaica, L. I., N. Y.*



Please mention number 905 when filling out card

Phase Microscopy

New equipment transforms an ordinary light microscope into an instrument that extends range of human vision far beyond limits of present microscopes. It represents a fundamental advance in use of microscope, called phase microscopy; and converted instrument is known as a phase microscope. Equipment comprises newly-developed light-controlling diffraction plates (Fig. 1) which, placed in an objective lens

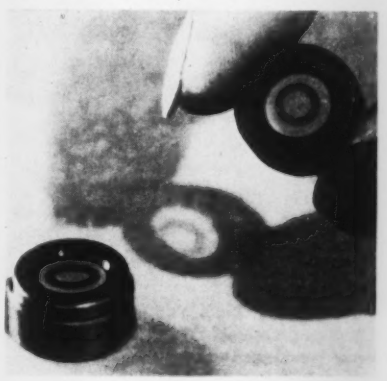


Fig. 1

system, make detail visible within a specimen by increasing, reducing or reversing contrast in image formed by microscope. A feature of new phase microscope is that it makes possible an accurate study of transparent living organisms. Formerly, to make them visible it was usually necessary to stain them with dyes, a procedure that kills most organisms. As a result, information gained with microscope was largely limited to the study of dead rather than living material. New phase microscope will be useful in study of plant and animal life, parasites, emulsions, replicas of metal and other surfaces, glass and plastic transparent surfaces, minerals, crystals, synthetic fibers and other materials. Shown in Fig. 2 photomicrograph are mold fragments (the small white objects) which cannot be seen with an ordinary microscope but which are made visible by new instrument. In industry, crystals otherwise barely visible can be seen and, conversely, regions within

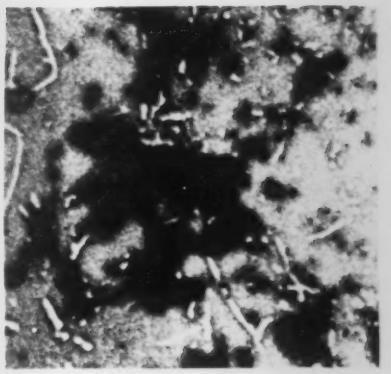


Fig. 2

certain substances can be made invisible to facilitate discovery of impurities. Equipment required to transform a standard light microscope into a phase microscope consists of a diaphragm for controlling light concentrated on a specimen and one of the new diffraction plates placed in the objective lens system. An auxiliary telescope used in place of the microscope eyepiece is helpful while centering the equipment. It is planned to make this equipment available for several models of Spencer microscopes. Investigations have disclosed that different types of the newly developed diffraction plates are preferable for various kinds of investigations. Further research will extend their use to additional applications.—*American Optical Co.'s Scientific Instrument Division, Buffalo, N. Y.*

Please mention number 906 when filling out card

Altitude Test Chambers

Two new models of high-altitude testing units have been added to maker's line. One has a maximum efficiency of 1" mercury absolute, or 75,000 feet of altitude; other model 2.7" Hg abs. or 55,000 ft. The 75,000-ft. unit features a climb rate of 2,500 feet per minute up to 55,000 feet. In the 55,000-foot unit, climb rate is increased to 5,000 fpm. up to 55,000 ft. Each unit can be dived at rate of 55,000 ft. to sea level in two minutes. Each has 12 ft.³ of testing space for testing instruments and materials, which can be observed through a heavy glass door. Units are powered by a 110-220-volt single-phase 60-cycle motor.—*Refrigeration Div., Bowser, Inc., Terryville, Conn.*

Please mention number 907 when filling out card

Constant-frequency Audio Oscillator

New constant-frequency audio oscillator has the accuracy of a laboratory standard, yet is rugged and compact in design and can be used as a field instrument or in-

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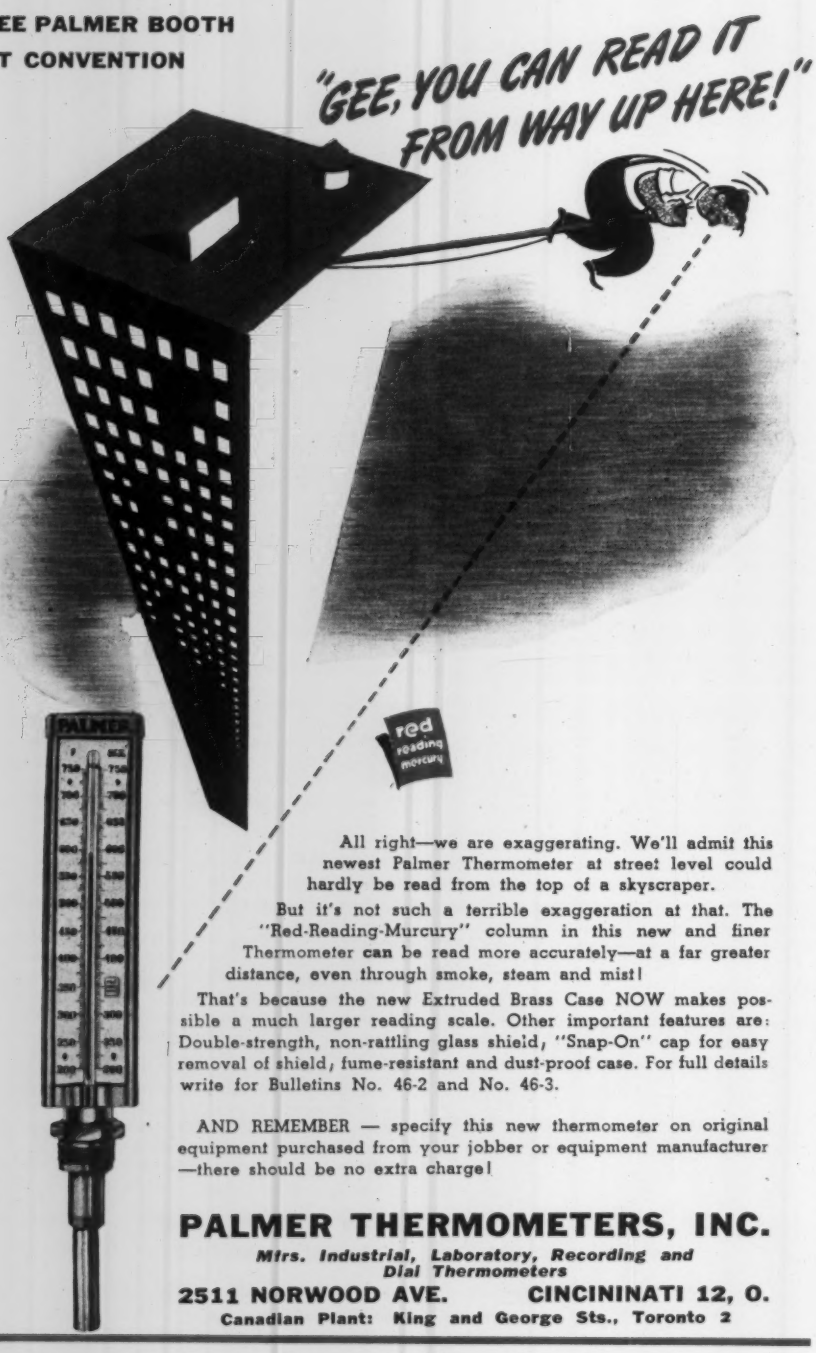

All right—we are exaggerating. We'll admit this newest Palmer Thermometer at street level could hardly be read from the top of a skyscraper.

But it's not such a terrible exaggeration at that. The "Red-Reading-Murcury" column in this new and finer Thermometer can be read more accurately—at a far greater distance, even through smoke, steam and mist!

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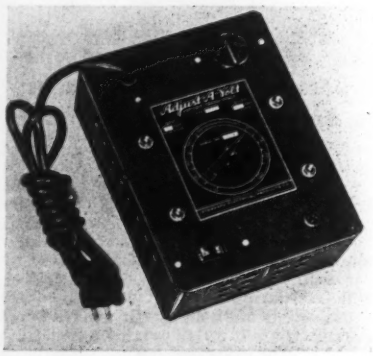
corporated in any equipment requiring a constant audiofrequency source. Frequency is controlled by a dynamically-balanced vacuum-sealed tuning fork unit which is temperature-compensated to maintain frequency within one part in five million per degree Centigrade. New oscillator is available for any specified frequency from 440 to 4000 cps. It can be furnished as a separate unit or complete with a power supply in a cabinet or mounted on a relay rack panel. Two isolated output signals are provided. One is a substantially pure sine wave having an output of 0.5 volt at 600 ohms; the second output is 30 volts at 25,000 ohms. — *Times Telephoto Equipment Inc., 229 W. 43rd St., New York 18, N. Y.*

Please mention number 908 when filling out card

Variable Transformers

New "LR Series Adjust-A-Volts" are said to fill gap between an isolation transformer and a variable-voltage transformer and to

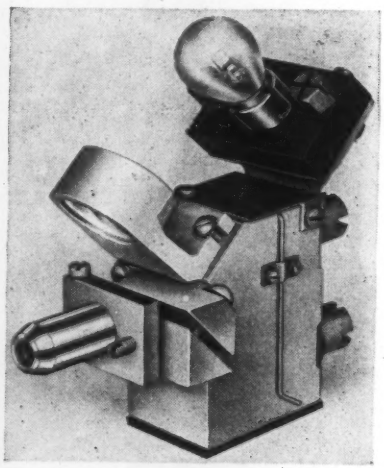


combine features of both. A smooth continuous voltage of 70-140 volts is provided at outlet receptacle. "Model LR-5" and "Model LR-22" (500 va.) were designed especially for laboratory and radio servicing use; "Model LR-10" and "Model LR-24" (1000 va.) are heavy-duty industrial (or laboratory) units. Principal feature of all models is isolated primary; some other features are apparent from illustration: jewel pilot light, calibrated dial, etc.— *Standard Electrical Products Co., Dayton 3, Ohio.*

Please mention number 909 when filling out card

Facsi Transmitter Optical System

New unit for picture-transmission systems, etc., consists of a photocell in a shielded housing, an exciter lamp, lens system and aperture plate assembled into one unit and so arranged that the photocell will be actuated by the light reflected from an elemental area 0.01" square of a surface located approximately one-half inch in front of the lens barrel. The scanned spot

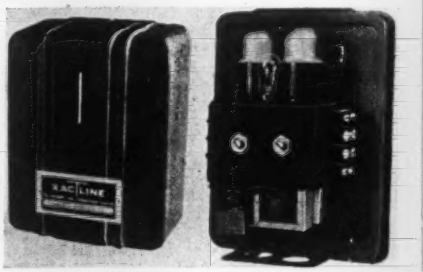


is flood-lighted in order that the photocell will not be affected by extraneous light. Photocell is specially designed to operate in a bridge circuit. Bridge output is 0.003 volt a.c. across a 2-megohm resistor. More output power may be obtained if size of scanned elemental area is increased by enlarging aperture plate in optical system.—*Times Telephoto Equipment Inc., 229 W. 43rd St., New York 18, N. Y.*

Please mention number 910 when filling out card

Automatic Temperature Controller

New "Xactline" temperature controller provides unusually close control: variation as low as 0.2°F. and power "on-off" cycles as short as three seconds have been attained. It accomplishes this without use of rotating mechanical parts; is factory-tested for immediate operation. According to manufacturer, "Xactline" is a solution for costly temperature variations prevalent in plastic, molding, tempering, aluminum heat-

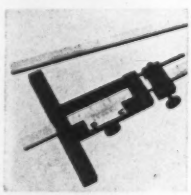


treating and other heat-processing fields; can be used on all types of electric furnaces, ovens, injection molding machines, etc., employing conventional millivoltmeter and potentiometer type controlling pyrometers or gas-fired equipment employing solenoid-controlled or motor operated valves. It is housed in a cast aluminum case 8¼" high, 6¼" wide and 3" deep, designed for surface mounting installation.—*Claud S. Gordon Co., 3000 S. Wallace St., Chicago 16, Ill.*

Please mention number 911 when filling out card

Process For Making Graduated Dials or Scales

New "Linotone Process" is a new method of producing graduating dials or scales with great accuracy. It is said to employ a unique principle developed out of wartime



needs, and to be applicable on practically any surface contour with a precision on circular dials of ± one minute of arc at 3" of radius. Tolerance of less than 0.001" in all dimensions is said to be assured. Process substitutes for costly tools and dies, a relatively inexpensive, but highly precise, master. Initial and unit costs being greatly reduced, great flexibility in design is possible — even permitting changes in design during production. There is practically no limit as to basic material. Aluminum, brass steel and most plastics are suitable for new process. To meet increase in use of plastics, company has developed a method of surface application of indices or graduations (not engraved) having same high precision found in Linotone engraving and offering unusual flexibility to designers who must meet com-

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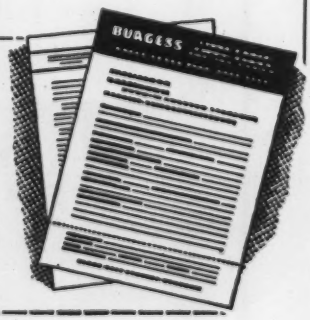
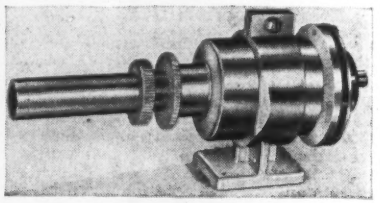


plex problems of legibility, illumination and precision. For example, new process is said to excel where transparent dials or scales must be graduated front and back.—*Linotone Corp., Div. of Mergenthaler Linotype Co., 563 W. 35th St., New York 1, N. Y.*

Please mention number 912 when filling out card

Facsi Recorder Optical System

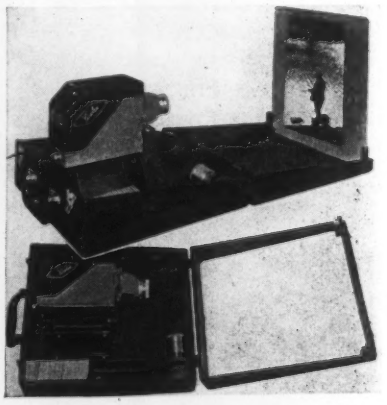
New unit for receiving-recorders of picture-transmission systems consists of a glow modulator tube having a modulating frequency range of 0-15,000 cps. incorporated in an optical system to provide a spot source of actinic light, the intensity of which will be directly proportional to current flow through lamp. Spot size approximately 1″ beyond end of lens barrel will be 0.010″ wide × 0.008″ high when a standard aperture plate is furnished. Aperture plates cut to produce other spot sizes are obtainable. Recordings may be made at 19 linear inches per second with 35-ma. current in lamp when using Eastman Type A transmission film or Royal Bromide F-1 paper. —*Times Telephoto Equipment Inc., 229 W. 43rd St., New York 18, N. Y.*



Please mention number 913 when filling out card

Wide-angle Slide Projector

New "Model AP-1" 35-mm. and 2″ × 2″ slide projector utilizes (for the first time in this country, it is said) an aspheric condenser system which gives the highest lumen output per watt input. This, coupled with the 2″ Luxtar projection lens, produces a more brilliant image of a given size in only two-fifths the projection distance needed for a conventional long-focus lens. Undistorted images, wire-sharp to the very corners, are said to be obtainable. Use of 2″ Luxtar lens not only cuts projection distances in less than half, but also makes practical a new type of slide projector: a complete and compact projection outfit, screen and all. Image is so brilliant that in broad daylight no shades are necessary. For larger pictures, Tuckaway screen section snaps off, and the Viewlex with 2″ Luxtar lens projects any size picture in two-fifths customary projection distance. When a picture is to be projected over a large audience, Viewlex is used with interchangeable Luxtar 5″ lens. Both these lenses are color-corrected Anastigmats. A permanently polished large rhodium reflector and concentrated-filament 150-watt bulb complete the optical system. Heat con-



trol is effected by using heat-absorbing glass to dissipate radiant heat before it reaches the slide. Convection currents are employed, through a multiple-chimney construction, to circulate cool air past the slide and through the lamphouse. Particular attention has been devoted to the chimneys and baffles, to avoid any "spilled light."—*Viewlex, Inc., 35-01 Queens Blvd., Long Island City 1, N. Y.*

Please mention number 914 when filling out card

250-4000-cycle Synchronous Motor

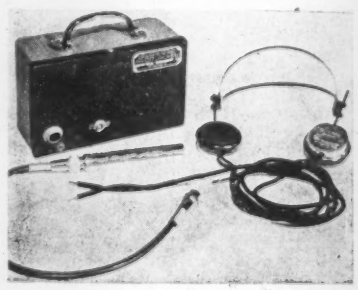
New motor of the phonic wheel type is specially designed to operate on frequencies from 250 to 4000 cps. with high efficiency.

Motor shaft speed in rpm. is equal to frequency in cps Gear reductions of 20-to-1 or 30-to-1 are available. Extremely uniform constant angular velocity is provided by the drive shaft. This motor is designed to operate in the plate circuit of a power amplifier capable of delivering 90 ma. at 450 volts. Maximum mechanical power is 1/100 hp. Six to nine volts a.c. to d.c. is required for starting. The motor is provided with an electrically-controlled clutch to start and stop the load by means of a control circuit.—*Times Telephoto Equipment Inc., 229 W. 43rd St., New York 18, N. Y.*

Please mention number 915 when filling out card

Portable Radioactivity Detector

New "Model 5A Radioactivity Detector" fill needs of: (1) prospectors for radioactive ores, who until recently were encumbered by rather large and bulky instruments; (2) laboratory users of radioactive preparations who desire a small lightweight radioactivity detector having its own batteries, independent of any external power source. "Model 5A" is "believed to be by far the lightest, most compact radioactivity detector ever offered on a commercial basis." It utilizes a highly dependable, efficient, Geiger-Muller counter tube, encased in a metal protecting housing connected to instrument proper by means of a short cable. Instrument proper weighs 4¾ lbs., measures 7" × 5" × 3", contains all auxiliary amplifying apparatus together



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Solve remote control and position repeating problems by adapting Microtorque Potentiometers to your particular needs. Built like a fine watch, Microtorque Potentiometers convert mechanical movement into proportional electrical voltages without causing excessive drag in sensitive mechanical measuring systems. A simple yoke adaption to the instrument pointer makes these tiny, ultra-low torque units ideal for take-offs from low torque indicating instruments. Microtorque Potentiometers may also be used as primary control elements in bridge type circuits to operate directly recorder controllers, recording galvanometers, oscillographs, polarized relays, and telemetering circuits.

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Resistance values 100 to 2500 ohms.
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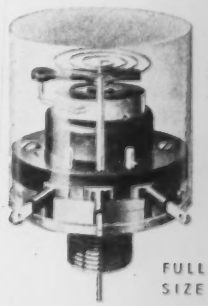

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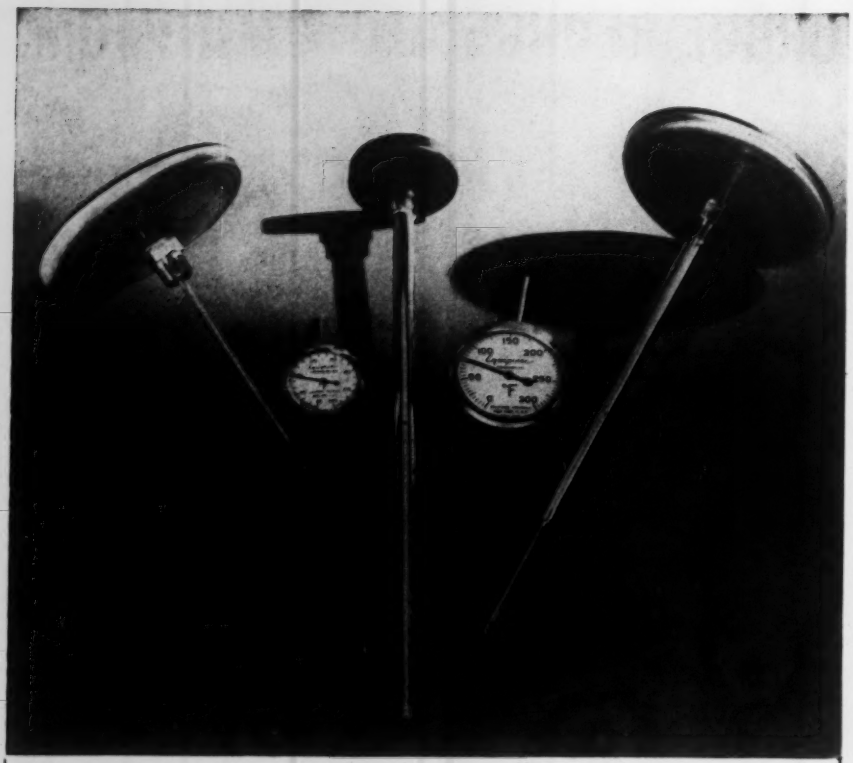

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Many standard ranges are available between the limits of minus 90°F. and 1000°F.

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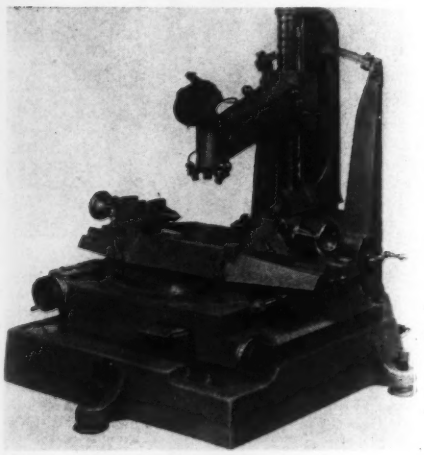
with necessary batteries and high-voltage source. By means of an oscillator, counter operating potential of over 1000 volts is obtained from standard miniature radio "B" batteries totaling only 135 volts. Operation is simple: toggle switch is turned to "ON" position and instrument is in complete operation within 5 seconds. Observer wears earphones and counts number of clicks per minute. By comparing this number with that obtained in absence of the radioactive material, a direct quantitative indication is obtained. Batteries will last at least one month with normal operation.—*Geophysical Instrument Co., Arlington, Virginia.*

Please mention number 916 when filling out card

Large Toolmaker's Microscope

New large Toolmaker Microscope has a mechanical stage with a coördinate range of 8" × 4" combined with 360° rotary motion and capable of supporting a load of several hundred pounds. Coördinate motion is by means of micrometer screws which read to 0.0001". Angular measurements can be read to 1 minute. Principal applications include inspection and measurement of large



tools, jigs, templates, machine parts, threads and similar items being held to close tolerances. Instrument consists of the mechanical stage, a 30-power microscope mounted on a support column which has micrometer tilt up to 15° each side of vertical, a removable cradle for supporting objects not readily mounted on flat surface of stage, and suitable surface and substage illuminators. Microscope is equipped with an internal protractor for rapid angular measurements to ½° and a Protractor Ocular Head by means of which angles may be read to one minute. Protractor ocular head is easily removed to permit use of Templet Ocular Head which accommodates thread and radius templet slides, all of which are available as accessories. Both rapid and fine focussing adjustments are provided. Magnifying power can be varied from 10 to 100 by means of interchangeable objectives. A camera attachment is also offered as an accessory. All scales can be read and all stage and microscope controls can be reached from a single operating position. Figures, line widths and surface finish of the scales have been selected for highest readability.—*The Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Illinois.*

Please mention number 917 when filling out card

Selenium Rectifier

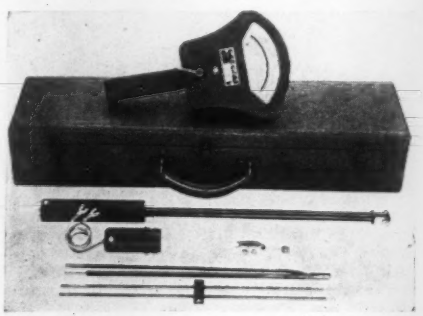
New tiny selenium rectifier to replace rectifier-type tubes is said to make possible considerably more efficient and somewhat smaller radios. Its operating life expectancy is many times that of the conventional 117-volt filament tube which it replaces. Being metal, it will withstand rougher handling than the tube. Receivers using new unit require no warm-up period. Consisting of

five selenium disks made on aluminum base plates, connected in series, new rectifier measures only 1" in diameter and ¾" long, can be mounted where a rectifier tube and socket won't fit, is easy to install: no socket or filament circuit, only a minimum of mounting hardware and two soldering operations. New unit is designed to withstand safely the inverse peak voltages obtained when rectifying (half-wave) 110-120 volts RMS and feeding into a capacitor as required in the various radio circuits when half-wave rectification of the a-c. line voltage is employed. Continuous currents up to 100 milliamperes can be obtained with a temperature rise well below the safe limits for selenium rectifiers. High momentary peak currents (as in charging a capacitor) are not detrimental to new unit.—*Tungar & Metallic Rectifier Div., General Electric Co., 1285 Boston Ave., Bridgeport, Conn.*

Please mention number 918 when filling out card

Portable Pyrometer Kit

New "Model 2863 Portable Pyrometer Kit" contains a high-resistance portable pyrometer (equipped with a "pistol grip" handle), a straight type extension with adapter for iron-constantan surface thermocouple,

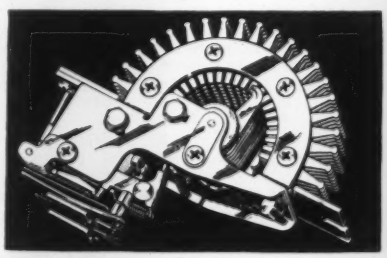


and an assortment of thermocouples. An additional adapter is furnished for use with bare and prong thermocouple tips which are also included in kit. Leatherette carrying case.—*Wheelco Instruments Company, 847 W. Harrison Street, Chicago 7, Illinois.*

Please mention number 919 when filling out card

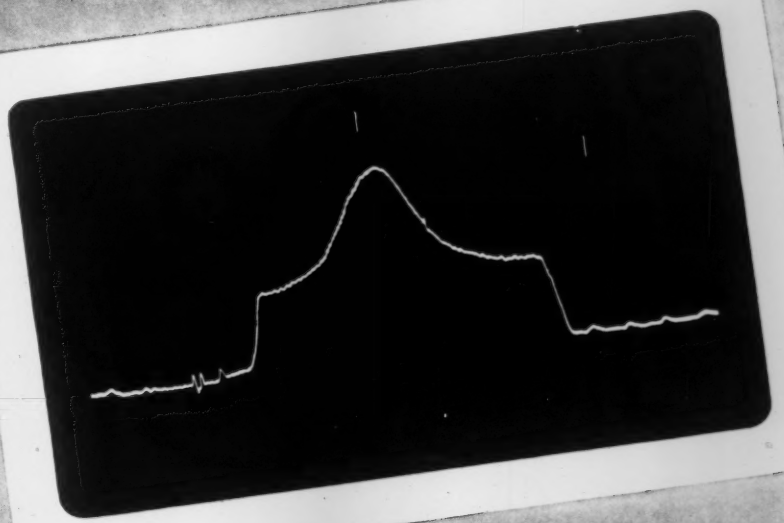
Spring-driven Stepping Switch

New spring-driven stepping switch is designed to perform any of following control operations: Selection: Under control of a



telephone dial or other impulsing device, switch will select any desired channel, or circuit path, out of 20 or 40. Sequence Control: Automatic control of a series of operations in a predetermined manner. Counting: Where initiation of impulses to a stepping switch is controlled by objects to be counted. Totalizing: Usually accomplished by a combination of switches which make individual counts and a totalizing switch. Maximum number of contacts for a 20-point switch is 8; for a 40-point switch, 4. Maximum operating speed with remote control is 30 steps per second. Average operating speed with self-cycling operation is 60 steps per second. Switch consists essentially of one or more wiper

Picture of a **PERFECT PICTURE!**



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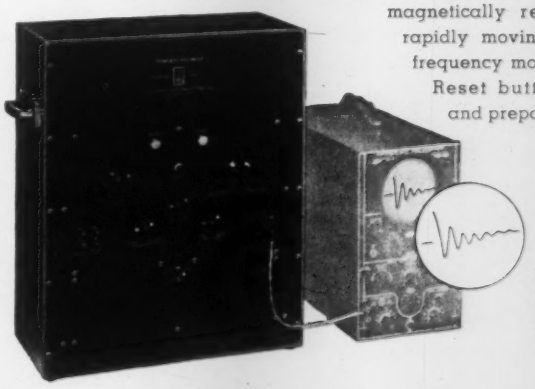

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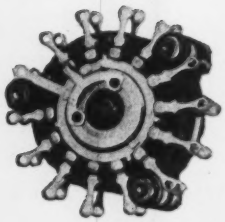

(SS-14-2)

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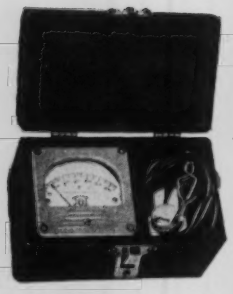
Automatically compensated, typical range for ovens, 0-650°F.



(32-JPI)

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Accuracy to ±0.3%; pocket size metal case; other ranges.

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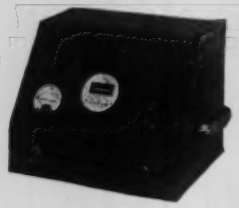
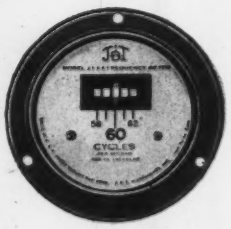
Accuracy, ±0.25%; six specific bands, to 3600 cps. No drift.



(39-VTF)

MOST COMPACT FREQUENCY METERS

Matches standard 2½" panel instruments. 60, 120 cps.



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3¼" mounting; encourages periodic servicing and tube-life checking.

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MULTIPLE RANGE PORTABLES

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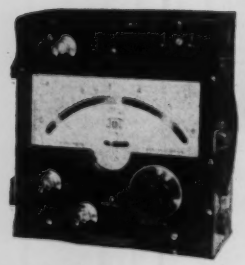

(70-PO)

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springs, fixed on a shaft rotated by a pawl-and-ratchet mechanism. This mechanism is actuated by an electromagnet which responds to momentary current impulses. When magnet is de-energized, wiper assembly is driven forward by a spring. Framework and armature are finished in cadmium. Bank contacts and wipers are phosphor bronze.—*C. P. Clare Co., 4719 West Sunnyside Avenue, Chicago 30, Ill.*

Please mention number 920 when filling out card

Oscilloscope Calibrator

New "Voltascope" is a small 3"×4"×5" self-contained instrument which is used to calibrate an oscilloscope under operating conditions, thereby extending usefulness of an oscilloscope in making quantitative measurements where previously only qualitative measurements were practical. "Voltascope" provides three standard signals whose values are 0.1, 1.0, and 10.0 volts measured from peak to peak. By means of a selector switch, any one of these standard signals may be compared to an unknown signal on screen of oscilloscope for any setting of the amplifier gain control. "Voltascope" operates from a-c. mains, and its accuracy is 1% at a line voltage of 117 volts. There is no warm-up time. Instrument may be used with any make of oscilloscope. —*Polarad Electronics Company, 135 Liberty St., New York 6, New York.*

Please mention number 921 when filling out card

Aircraft Ignition Wiring Tester

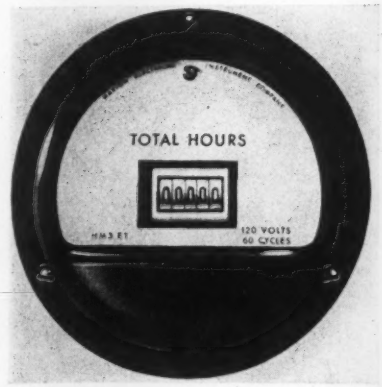
New "Vibrotest Model 241" is an aircraft ignition wiring tester which is claimed to embody advanced features for convenience, speed and dependability. It indicates insulation resistance in ignition harness, without costly and time-consuming labor of dismantling harness or engine cowling. Location of trouble in spark plugs, sleeves, wire, insulation at any point of the engine, is said to be a matter of moments. Power source is self-contained; no cranking; no auxiliary power supply needed. "Simply press a button, and read instantly." Every possible ignition trouble is claimed to be covered. Range is 0 to 2000 megohms at 1000 volts

potential. Special scale distribution puts 150-megohm point about one-third up scale. Part of scale arc below this 150-megohm point is colored red; remainder of scale arc is green. Correct indication of the trouble is therefore instantly at sight. 12-foot leads with instantly-applicable terminals are provided. Leads are housed in the case cover. Instrument is protected by shatter-proof glass. A metal shield over Bakelite portion prevents mechanical injury. Tester weighs 17 lbs.—*Associated Research, Inc., 231 So. Green Street. Chicago 7, Illinois.*

Please mention number 922 when filling out card

Elapsed Time Indicator

New "Model HM3" Elapsed Time Indicator operates on 115-volt 60 cycle supply, indicates elapsed time from zero to 9,999.9



hours, conforms with standard JAN I-6 mounting dimensions. Unit features maker's glass-to-metal hermetic seal construction which makes it applicable in chemical and allied industries where corrosive fumes or high humidity would attack conventional instruments.—*Marion Electrical Instrument Co., Manchester, N. H.*

Please mention number 923 when filling out card

Copper-oxide Rectifiers

New "Coprox" copper-oxide rectifiers for battery chargers are of a new design said to give maximum output in minimum space. They are rated for 2, 3 and 4½ volts d-c. output, with direct current up to 1½ amperes. New models have special features to combat aging. Lead wires are pre-soldered, and other types of terminals are specially designed, to prevent overheating during assembly.—*Bradley Laboratories, Inc., 82 Meadow Street. New Haven, Conn.*

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Set of Five Gage Blocks

New "Tool Makers" set of five Ellstrom master gage blocks, unconditionally guaranteed accurate to ± 8 microinches, is especially assembled for individual ownership

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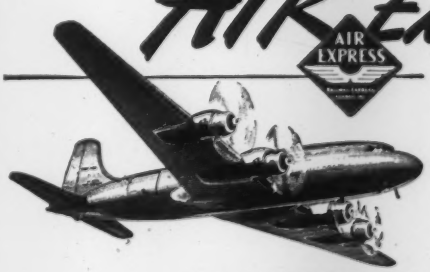

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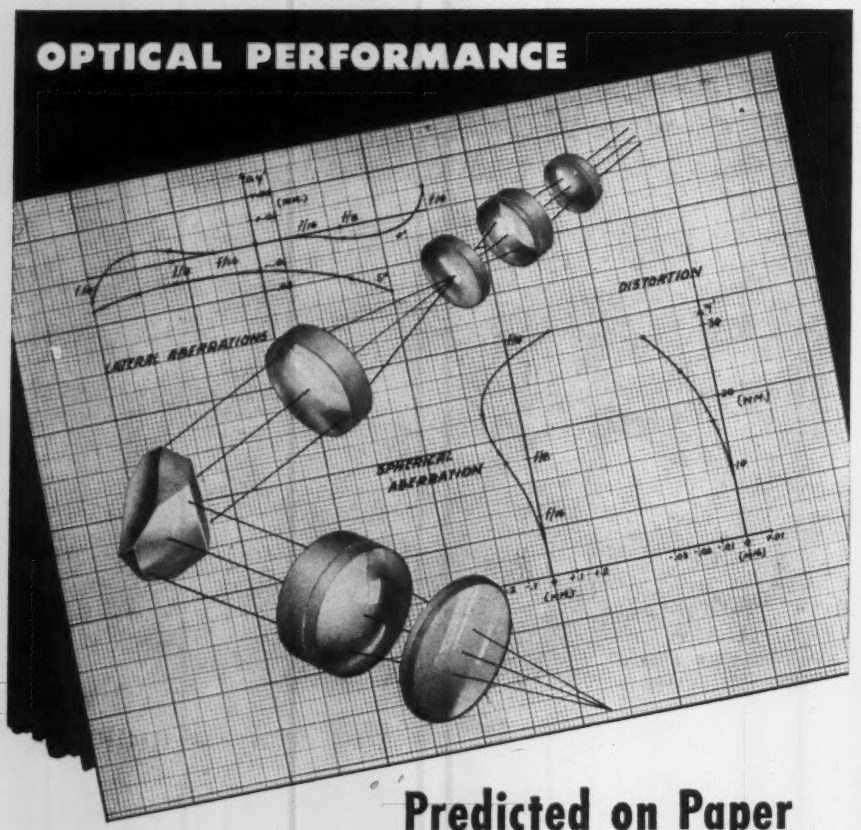

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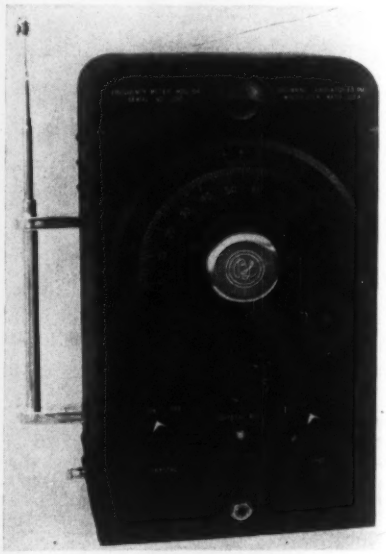
Please mention number 925 when filling out card

Wide-range Frequency Meter

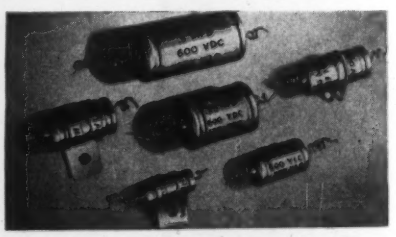
New "Model S-4 Frequency Meter" covers specified frequencies in range from 1.5 to 100 Mc., may be employed for checking frequency of either AM or FM transmitters to an accuracy of 0.0025%. A 100-kc. crystal is used as a secondary standard. Its frequency may be checked against WWV, assuring an accuracy of 5 cycles in 10,000,000. Checks of crystal against ECO may be obtained by means of a cathode-ray indicator to better than 1 part in 1,000,000. A machine-cut dial with vernier is employed for tuning ECO. As noted from photograph, a telescoping antenna allows convenient coupling to the transmitter. Dimensions: 13 3/8" × 7 5/8" × 6 5/8". Weight: 15 lbs.—*Browning Laboratories, Inc., Winchester, Mass.*



Please mention number 926 when filling out card

Feed-through Capacitors

New hermetically-sealed metal-cased feed-through capacitors are said to be ideally suited to communications equipment for by-pass, coupling, and filtering purposes; also to prevent high-frequency noise signals from entering communication circuits. New units are said to differ from conventional capacitors in that current feeds through capacitor with exceptionally low inductance, impedance and resistance. Designed specifically for attenuation of high-frequency voltage components, they have an unusually low power-factor and are unaffected by temperatures as high as 85°C. Hermetically-sealed metal containers are equipped with

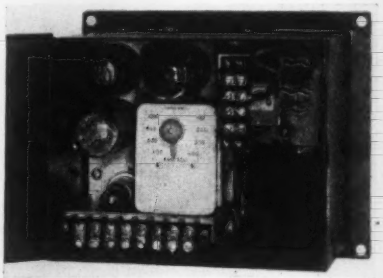


universal side mounting brackets with foil ends fully swedged by a new C-D process. D-c. rated voltages are 600 volts, a-c. rated voltages 330; both at 15 amperes. Capacitances range from 0.01 mfd. to 0.5 mfd. Other ratings can be designed to fit specific circuit requirements to attenuate undesirable high-frequency factors.—*Cornell-Dubilier Electric Corp., South Plainfield, N. J.*

Please mention number 927 when filling out card

Temperature Limit Switch

New "Ashcroft Thermal Protector" is a thermocouple-actuated limit switch, for such applications as industrial ovens, dryers, bearings of large motors, blower wheels, flue gas stacks, reheaters, etc. Temperature chosen as the high limit is set by an operating knob located inside case where it will not be tampered with. If this temperature



is reached, the device will stop the apparatus before excessive damage is done, or it can be arranged to sound an alarm or light a light. If desired, any or all of these functions can be performed at the same time. In addition to protection from excessive temperature, device will "fail safe" in case of burning off or breaking of thermocouple, failure of power supply, tube or mercury switch. A still further protection is provided by a manual reset. This makes certain that something is done to correct the cause before equipment is damaged or production is seriously interrupted. Device is designed with two ranges, 100°F. to 1000°F. using an IC couple, and 800°F. to 2000°F. using an AC couple with an accuracy of 2% of range at set point. Two or more couples may be connected, in series if desired. Cold junction is located in unit and is compensated to ambient temperatures of 50°F. to 135°F. and relative humidity up to 100%. Current characteristics, 115-230 volts 60-cycle a.c. 15-20 watts. There are no open contacts in device; circuit for signal and power input to apparatus is a standard 4-amp., 250-volt mercury switch. Case is designed for universal mounting either flush or wall.—*Manning, Maxwell & Moore, Inc., Bridgeport 2, Conn.*

Please mention number 928 when filling out card

Ultrasensitive D-c. Relay

New ultrasensitive d-c. relay is completely enclosed in a clear cellulose acetate plastic case which keeps dust or dirt from the contacts while affording instant visual inspection. Base is heavy black molded Bakelite of high dielectric strength and insulation and negligible water absorption. Operating power required is only 2½ milliwatts with careful adjustment and light contact loads and 5 milliwatts for positive operation. Armature and pole are of nickel-iron alloy, hydrogen-annealed for high permeability and low retentivity. It has high overall sensitivity with small make-break coil current differential. Armature is counterbalanced to allow operation in any position and prevent action due to moderate vibration. A vernier screw is provided for coil spring tension setting. Contacts are of pure silver, single-pole, double-throw, 1-ampere on 110-volt a.c. non-inductive load. Coil is of standard resistance from 1 ohm to 10,000 ohms up to 30,000 on special order, has cellulose acetate insulation, varnish

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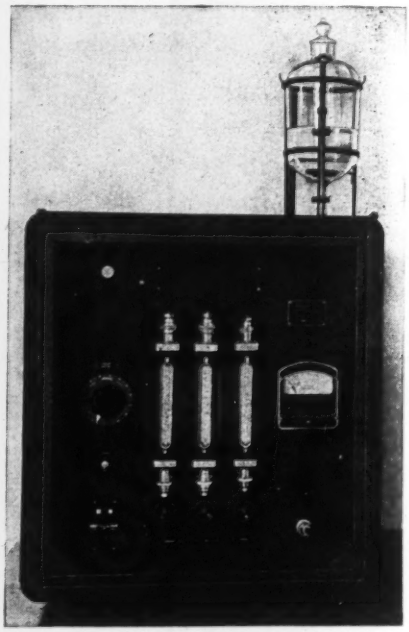
vacuum impregnation. Terminals are solder lugs and screws recessed on bottom of base accessible through panel or through knockouts on side of base. Surface mounting in any position by means of two No. 6 screws. Dimensions 2" × 2 9/16" × 1 1/2" high. Weight 6 1/4 ounces.—*Advance Electric & Relay Co., 1260 W. Second St., Los Angeles 26, Calif.*

Please mention number 929 when filling out card

Halogenated Hydrocarbon Analyzer

New "Westvaco Halogenated Hydrocarbon Analyser" safeguards workers exposed to carbon tetrachloride, trichlorethylene, chloral and other halogenated hydrocarbons. Available in both portable and permanent-installation forms, instrument determies halogenated hydrogen concentra-



tions and, when used in conjuction with maker's conductivity recorder, provides a continuous record of contamination. In operation, a continuous sample of atmosphere is mixed with hydrogen in fixed proportion, and passed through a quartz combustion tube maintained at above 800°C. so that decomposition to the corresponding hydrogen halide (such as hydrogen bromide or hydrogen chloride) occurs. Hydrogen halide is continuously absorbed in a measured stream of distilled water and the electrical conductivity of water solution is measured and recorded. Method was described by Williams, Haines & Heindel in *I&EC Analytical Edition*, Vol. 17, 1945, page 289, and apparatus developed at S. Charleston plant of Westvaco Chlorine Products Corp. Semi-portable unit is enclosed in an aluminum and magnesium cabinet approx. 2' × 2' × 2'; overall weight approx. 125 lbs. exclusive of recorder; operates on 115-v. 60-cycle a-c. supply with a current consumption under 10 amperes. Permanent installations, providing for tests of up to six separate sampling points, are also offered. A 4-point analyzer can be supplied mounted and completely enclosed in a steel cabinet measuring approx. 70" high × 18" deep × 22" wide, provided with four ball-bearing rubber wheels; weight approx. 500 lbs.—*Industrial Instruments, Inc., 17 Pollock Ave., Jersey City, N. J.*

Please mention number 930 when filling out card

Universal Solenoid Relay

New "Bulletin 700 Universal Solenoid Relays" are available in 2-, 4-, 6-, and 8-pole construction. Unusual flexibility is said to be outstanding feature: a simple shift

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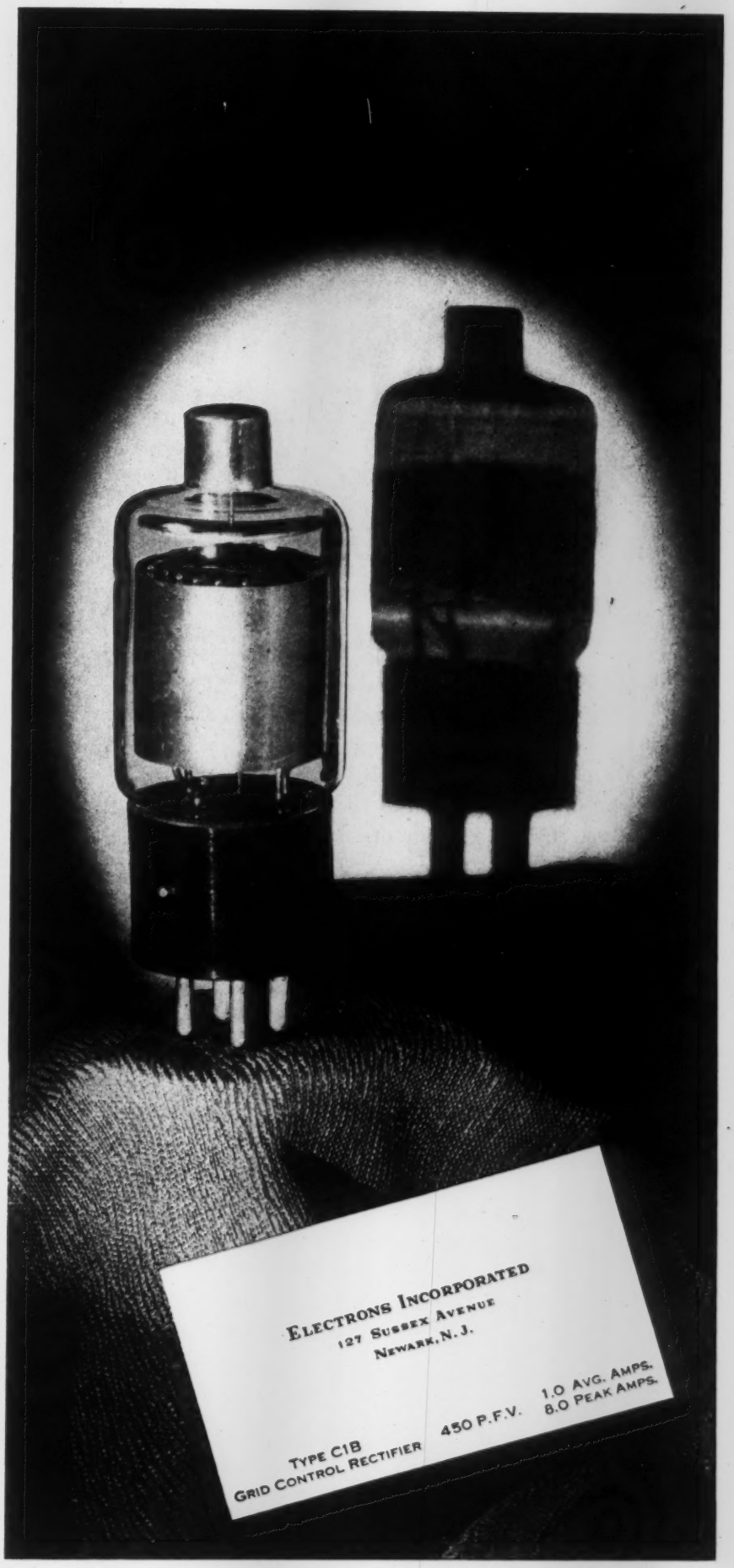

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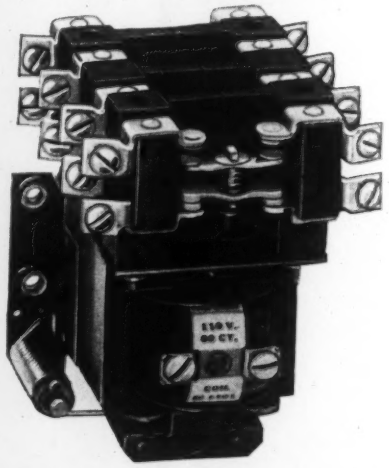
of connections makes it possible to change a set of normally-open contacts to normally-closed operation, or vice versa. All contacts on 2-pole and 4-pole relays are of universal type. The 6- and 8-pole relays have only four sets of universal contacts; remaining contacts are of conventional, normally-open or normally-closed type which cannot be

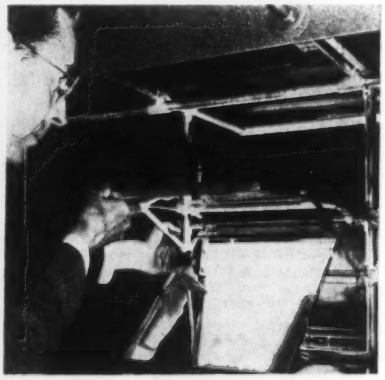


changed in the field. These relays have a maximum current rating of 10 amperes, noninductive, and can be obtained for operation on 25, 30, 40, 50, and 60 cycles with voltages of 6, 12, 24, 32, 64, 110, 220, 440, 550, and 600 volts. Universal type should only be used for switching circuits of like polarity and cannot be used as reversing switches. New relays can be obtained either in open style or mounted in an enclosure. Three enclosures are available: standard, general-purpose NEMA Type 1, sheet steel enclosure; watertight and weatherproof NEMA Type 4, cadmium-plated cast-iron enclosure; and cast-iron NEMA Type 7 enclosure for use in hazardous gas locations. —*Allen-Bradley Co., 1311 South First St., Milwaukee 4, Wis.*

Please mention number 931 when filling out card

Auxiliary Fluoroscope for X-ray Unit

New auxiliary fluoroscope fits neatly into specimen compartment of "Norelco" Searchray 150" unit; consists of a collapsible pipe framework with auxiliary fluoroscopic screen



mounted for easy adjustment; makes efficient fluoroscopy of small objects possible in a specimen compartment designed primarily for work of much larger dimensions. It makes it possible to reduce distance of specimen from the target to approx. ⅓ that which obtains when specimen is mounted on floor of compartment. This quadruples screen intensity and improves the clarity of image. In addition, radiographs may be made with shorter exposure time. New auxiliary fluoroscope is collapsible and can be swung out at will to permit use of full

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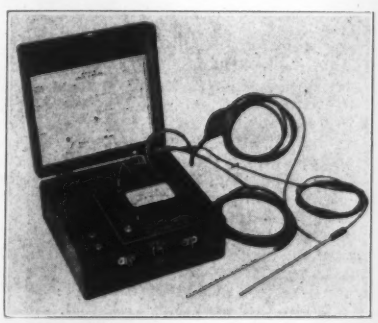

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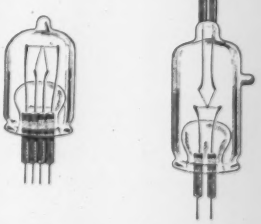

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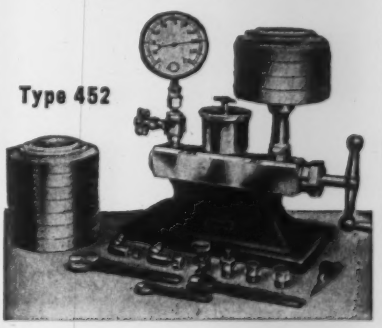

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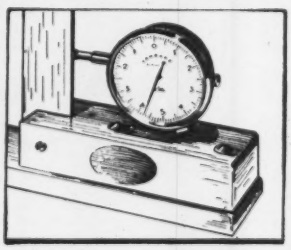

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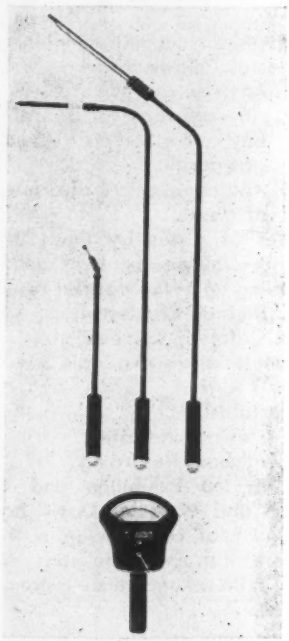
compartment when required. A lead glass window, inserted in a removable cutout in sliding compartment door, permits operator to view special screen to observe positioning or functioning of equipment under study.—*North American Philips Co., Inc., 100 East 42nd St., New York City.*

Please mention number 932 when filling out card

Portable Pyrometer with Plug-in Thermocouple Extensions

New Extension Type Portable Pyrometer permits a choice of plug-in angle extensions where a number of applications necessitate versatility. High-resistance millivolt meter movement consists of baked, processed coils, supported by lapped pivots in highly-polished sapphire jewels. An Alnico #5 magnet provides increased ruggedness without a loss of sensitivity. A calibrated Breguet spiral automatically corrects readings for variations in cold-junction temperature. Plug-in extensions are available in either straight, 45° or 90° angle types. Adapters permit choice of material and calibration of thermocouples. The pyrometer is contained in a sealed, dustproof, aluminum case having a "pistol grip" handle which may be locked in a horizontal or vertical position for ease of operation. A 3 9/16" reflector scale prevents parallax errors in reading. Dual Iron Constantan scales are calibrated from 0 to 600°F. or 0 to 1000°F. (with C. equivalents) and dual Ghromel-Alumel scales are calibrated from 0 to 1600°F. or 0 to 2500°F. (with C. equivalents). Bare, Marshall or Surface thermocouple tips may be selected.—*Wheelco Instruments Company, 847 W. Harrison St., Chicago 7, Illinois.*



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New hydrocarbon solvent, decahydronaphthalene, also known as decalin or naphthalane, removes the non-wetting film formed on laboratory equipment by silicone lubricants. (Best cleaning methods previously developed involved use of caustic solutions which had to be carefully watched to avoid etching the glass.) This discovery was reported by G. Constabaris of Department of Chemistry, University of British Columbia. Effectiveness of this solvent for removing both "DC Stopcock Grease" and "DC High Vacuum Grease" has been verified in the laboratories of Dow Corning

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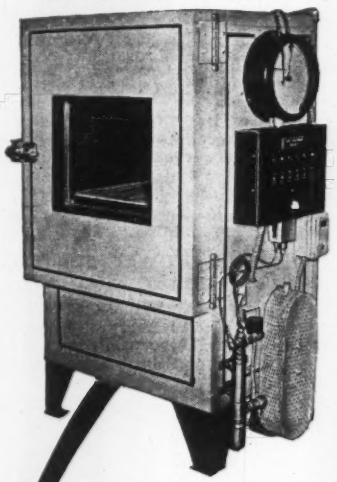

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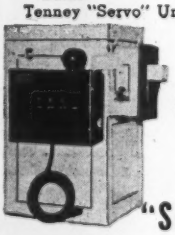
- Tenney "Servo" Units (shown below)



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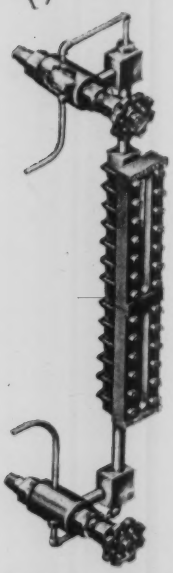

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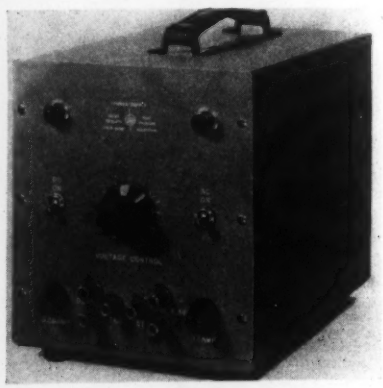
Corporation. On the basis of these tests, following procedure is recommended: Fill apparatus with warm decahydronaphthalene (decalin) and allow to stand for 2 hours or more if necessary. 2. Drain and rinse once or twice with acetone and dry with a stream of filtered air. 3. Decahydronaphthalene can be reused several times before it becomes ineffective. These laboratory tests also indicated that only a very thin film of these silicone lubricants is necessary to provide effective lubrication and that judicious use of the greases and frequent cleaning should prevent surface contamination. It was also reported that the ordinary surface effects observed in burettes are for the most part due to dust in the atmosphere. Objectionable surface films were also observed in glassware lubricated with other types of grease.—*Dow Corning Corp., Midland, Mich.*

Please mention number 934 when filling out card

Regulated Power Supply

New "Model 710A Regulated Power Supply" is a compact (7¼" × 8" × 11¾"), light-weight (18 lbs.) source of regulated voltage for general laboratory and production use. Output is continuously variable

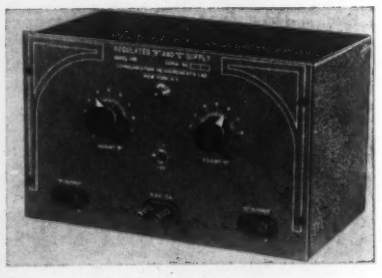


from 180 to 360 volts, and will remain constant to within 1% for loads from 0 to 75 ma. and for line-voltage variations of ± 10%. Either positive or negative output terminal may be grounded. Total noise and hum is less than 0.005 volts for any condition of operation. Unit also provides 6.3 volts a.c. center-tapped for heating filaments. — *Hewlett-Packard Co., Palo Alto, Calif.*

Please mention number 935 when filling out card

Dual Power Supply

New "CML 1115" Dual Power Supply combines two independent regulated power sources: The "B" supply furnishes a continuously-variable d-c. voltage from 180 to 300 volts, at 70 ma., with a maximum ripple of less than 25 mv. Negative side of supply is isolated from chassis, so that +B may be grounded if it is desired to use the supply as a source of grid bias for tubes which draw heavy grid current. A continuously-variable d-c voltage from 0 to 75 volts with less than 7 mv. ripple is furnished by the "C" supply. Panel controls are provided to adjust output voltages throughout the ranges indicated. Independent insulated panel connectors are provided for the high-voltage



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PROPORTION AND CONTROL THE FLOW OF GASES AND LIQUIDS

The use of North American adjustable port valves is desirable whenever a definite minimum and maximum flow of a medium is required and where it is necessary to vary that flow intermittently or continuously between these limits. They can be used singly, or in pairs when simultaneous and proportional control of two mediums is advantageous.

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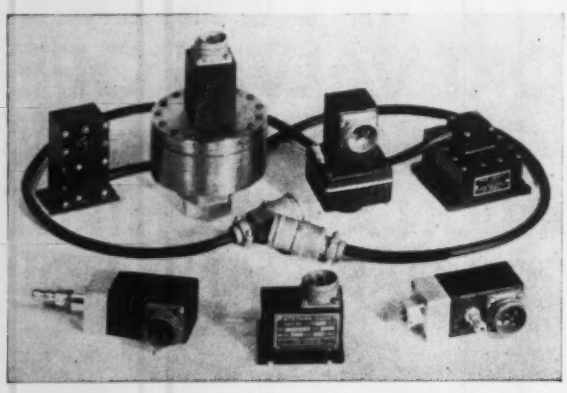

This portrait illustrates the remarkable versatility of the Statham Unbonded Strain Gage. The Statham Gage measures movements of ±0.0015 inches full scale to within a few microinches, when used as a displacement indicator, or forces of ±4 oz. to ±48 oz., when used as a dynamometer. These ranges may be extended by means of spring or lever systems.

The basic unit is incorporated into Pressure Transmitters and Accelerometers. The Transmitters are made in gage, differential, and absolute types, and in full-scale ranges of 0-0.1 psi. to 0-10,000 psi. Accelerometers, for vertical or horizontal mounting, have ranges of ±1.5 G to ±500 G.

The power requirements are simple; and the output is sufficient to operate a panel-type microammeter, recording potentiometer, or cathode-ray oscilloscope.

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Readings from 2 microamperes to 1 ampere on 5 ranges, and 20 microvolts to 1000 volts on 9 ranges.

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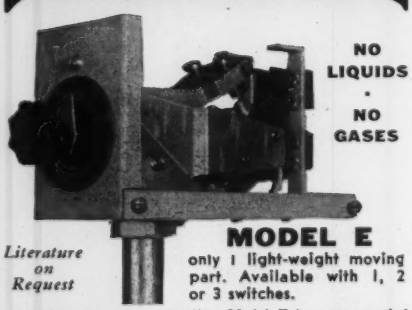
BURLING
TEMPERATURE
LIMIT SWITCHES



NO LIQUIDS
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NO GASES

Literature on Request

MODEL E
only 1 light-weight moving part. Available with 1, 2 or 3 switches.

As a 3 switch model, Burling Model E is recommended for use (a) where load is divided into 3 parts, (b) where 1 switch is used for controlling, one as a high limit, one as a low limit, (c) to give definite stops or position to a 3 or 4 position diaphragm motor, (d) to give 3 speed control of variable speed motor.

Accurate, rugged, dependable. Corrosion and heat resisting tube. Dial pointer for easy setting. Locking screw locks temperature setting. Increased adjustable range to 700-1000°. Dimensions: 7¼" x 2¾" x 3½". Vapor tight base and cover with gasket available at slight extra charge.

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Newark, N. J.

terminals. Panel binding posts are supplied for connection to a 6.3-volt, 2-ampere, unregulated a-c. filament supply. An a-c. power switch and pilot light are also mounted on front panel. — *Communication Measurements Laboratory, 120 Greenwich St., New York, N. Y.*

Please mention number 936 when filling out card

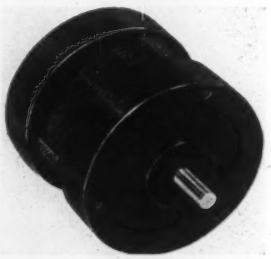
Television Rectifier

New "Type 1Z2" is a small-bulb high-voltage vacuum rectifier of low current capacity. Low cathode heating power and low dielectric losses make this tube suitable for use in rectifiers operating from a radiofrequency supply. Two tubes in a voltage doubler will supply 20,000 volts at 2 ma. d.c. Maximum ratings: Peak inverse voltage, 20,000; Average plate current, 2 ma.; Peak plate current, 10 ma. Characteristics: Filament voltage, 1.5 volts; Filament current, .29 amps; Min. resistance in series with plate, 20,000 ohms; Anode-to-filament capacitance, 0.6 mmf.—*Chatham Electronics, 475 Washington St., Newark 2, N. J.*

Please mention number 937 when filling out card

Low-inertia Motor for Remote-control Uses

New "Model 2A Servo-Motor" is said to be an exceptionally compact, low-inertia 60-cycle, 2-phase motor for remote-control applications. It does not run single phase



and the fixed phase may be continuously energized. It can be wound to operate from 10 to 80 volts, or more; 60 cycles. Impedance is practically constant from full speed to stall; and standard stall torque, 1½ oz.-in., can be changed as required. Stack length may be changed ±50% to suit torque requirements. Motor is furnished with separate leads for each phase; terminal board may be attached to rear of motor, if required. Designed for small space application, it "fits inside your hand."—*Transicoil Corp., 114 Worth St., New York City.*

Please mention number 938 when filling out card

Terminal-protecting Device for Electrical Instruments, etc.

New "Heyco No. 4 Strain Relief" will not injure insulation or wire to which it is applied, will absorb pull, push and torque

Micro-Dimensional

WIRE & RIBBON
for
VACUUM TUBE
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✓ Many sizes and alloys for a range of applications such as miniature tubes, hearing aid tubes, low-current-drain battery tubes, receiving tubes . . .

✓ Melted and worked to assure maximum uniformity and strength. WIRES drawn to .0004" diameter; RIBBON rolled to .0001" thickness . . .

✓ Wollaston Process Wire drawn as small as .000010"; made to your specifications for diameter and resistance.

✓ SPECIAL ALLOYS made to meet individual requirements. Write for list of stock alloys.

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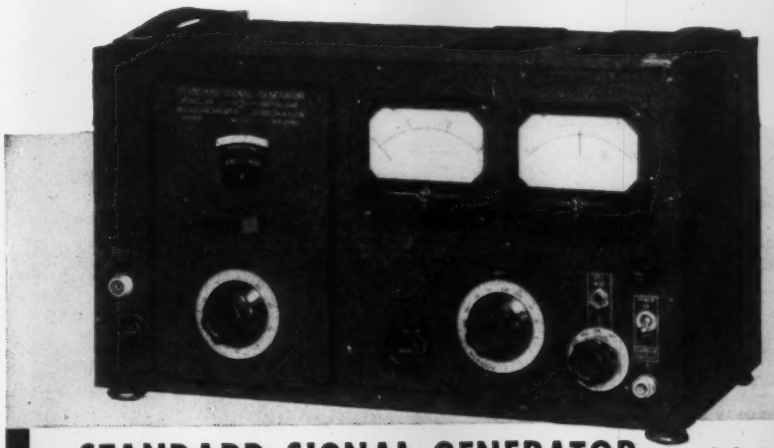

STANDARD SIGNAL GENERATOR Model 80

CARRIER FREQUENCY RANGE: 2 to 400 megacycles.

OUTPUT: 0.1 to 100,000 microvolts.
50 ohms output impedance.

MODULATION: A M 0 to 30% at 400 or 1000 cycles internal.
Jack for external audio modulation.
Video modulation jack for connection of external pulse generator.

POWER SUPPLY: 117 volts, 50-60 cycles.

DIMENSIONS: Width 19", Height 10¾", Depth 9½".

WEIGHT: Approximately 35 lbs.
Suitable connection cables and matching pads can be supplied on order.

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Standard Signal Generators
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FM Signal Generators
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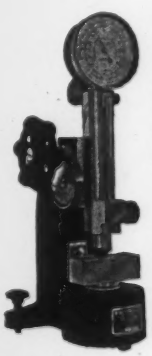

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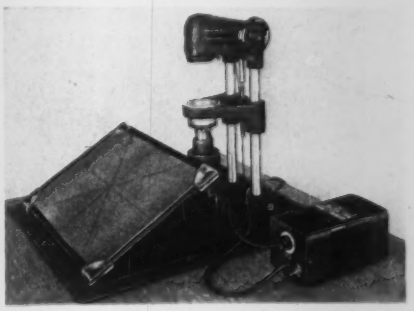


THIS COMPARATOR is equipped with a new circular type of **Surface Illuminator.** In addition to an enlarged shadow image of the work contour, **it also shows a reflected image of the work surface.** At the start of a job it can check tool forms, gages, tool adjustments. As work progresses, spot inspection with the Wilder Projector shows tool wear, enabling correction before such wear causes rejects. This program followed throughout the job, insures that the last piece as well as the first will be well within limits. Many shops use the Wilder for 100% inspection. Reasonable price. See it at Harris Pump & Machinery Co. booth No. 68-69 Instrumentation for Tomorrow exhibit, Pittsburgh. Write for Bulletin.

GEORGE SCHERR INC.
200 Lafayette St. New York 12, N. Y.

INKLESS TEMPERATURE RECORDER

remote recording from resistance temperature detectors

Consisting of two compact units (an inkless strip-chart recorder and an external power unit), the new G-E Type CF-2 temperature recorder can be used with resistance temperature detectors (RTD's) already installed in generators, transformers, and other large electric apparatus, or with separate detector units to record temperature in ovens, heat-treating tanks, refrigerating machines, air ducts, and liquid-handling systems.

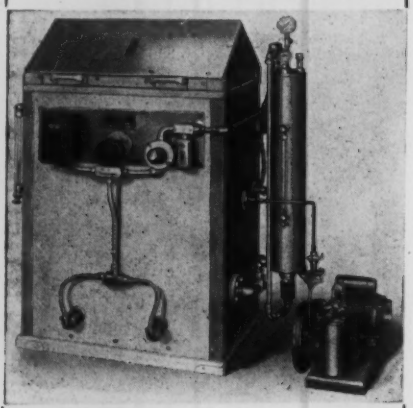
ELECTRICALLY OPERATED — SCALE RANGE 20-140 DEGREES C

On a four-inch strip chart, this equipment produces a clear record of the temperature variations that effect resistance changes in standard, ten-ohm RTD's heretofore used mainly with indicating instruments. The 115-volt Telechron motor can be adjusted to provide record lengths of from eight days to two years on a single 65-foot chart. By using a suitable transfer switch, a single equipment may be used with several detector units for multiple recordings.

Lightweight and portable, the Type CF-2 temperature recorder is probably the lowest-priced, remote-recording instrument on the market. And to suit diverse requirements, a variety of RTD's are available as accessories. Complete details are listed in Bulletin GEA-4572. Call the nearest G-E office for your copy or write to *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

SALT FOG
CORROSION TEST EQUIPMENT



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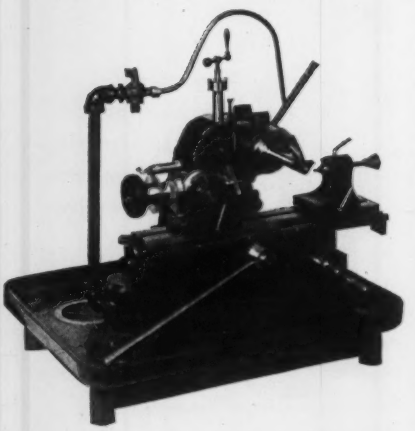


R. P. GALLIEN
220 WEST FIFTH ST., LOS ANGELES 13, CALIF.
Precision Instrument Equipment — Tools and Supplies

from the cord set, and eliminate all strain on terminals. It is molded from heat-resistant plastic. Installation is quick and easy —it is only necessary to slip the relief on the wire and snap it into the hole. Device eliminates sewing and knot tying, prevents fraying of wire and acts as an insulating grommet. It is designed especially for POSJ —1/64" wire. Other models will be added later which will accommodate larger wire sizes. Samples for POSJ—1/64" will be mailed on request.—*Heyman Mfg. Co., 78 Michigan Avenue, Kenilworth, N. J.*

Please mention number 939 when filling out card

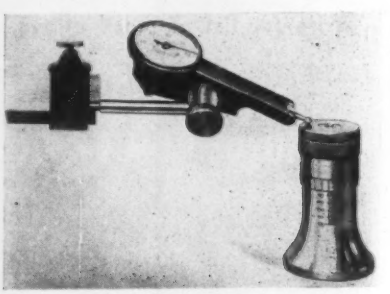
Connector for Low-level Sound

New "Type XL Series" is said to meet requests of radio, sound and electronic manufacturers and broadcasting engineers for a small multi-contact electric connector —plug and receptacle—"that would ultimately become a basis for standardization for low level-sound uses by the industry." It consists of the following: (1) "midget" size, 2 3/32" overall length with a max. diam. of 5/8"; (2) light weight, two plug types 0.0792 and 0.0992 lb. respectively; (3) latch lock device similar to "Type P;" (4) polarizing means similar to "Type AN" and "K" aircraft connectors; (5) removable inserts with tapped metal armor for insert retaining screw; (6) cable relief spring or removable cable clamp; (7) contact No. 1 engaging before Nos. 2 and 3 to be used for ground circuits, if desired; (8) rugged die-cast zinc shell with cadmium plate finish now, bright nickel when available; (10) three 15-amp. silver-plated brass contacts in phenolic insert to accommodate No. 14 B&S stranded wire and ample voltages for sound applications. — *Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, Calif.*

Please mention number 940 when filling out card

Adjustable Gage for Tool Settings, etc.

New "Micro-Planer Gauge" offers master setting of measurements in thousandths of an inch. It uses regular micrometer graduations and positive protection lock. Base is absolutely parallel to checking surface. Gage is designed for setting cutting tools on planers and shapers, in conjunction with gage blocks, and with sine bar in grinding angles, or as an indicator for transferring measurements. It consists of a base and



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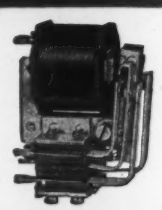
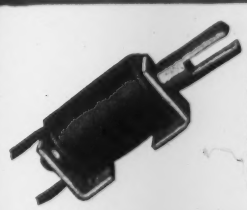
Whether the principle is electronic or magnetic . . . here are some of the latest, greatest basic design Guardian Relays, Solenoids and Stepping Switches we are privileged to present to design engineers.

Each unit offers an unlimited number of variations . . . often making a *standard* Guardian Relay a "special," effecting big savings in time and money. Highly efficient, compact, low-priced, long life, you can depend on it—they'll increase the dependability and quality of your product.



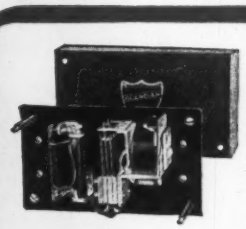
Series 40 A. C. Laminated Relay

This laminated relay is designed to produce maximum output with minimum current input. Typical uses include control of call system bells; auxiliary for automatic radio tuning; remote control of fractional motors; safety devices; instruments; sound movie auxiliaries.



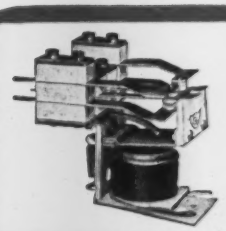
Series 1-A Solenoid

The series 1-A Solenoid by Guardian is one of numerous types for intermittent and continuous duty. Applications include valve control and operation; electrical locking; clutch and brake operation; material ejector; spray gun operation among others.



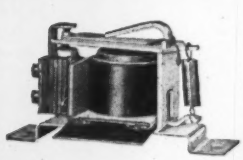
Series T-110 Time Delay Relay

This relay employs a resistance wound bimetal strip to achieve a delayed operation from 10 to 60 seconds. Current flows through the windings generating heat, causing the bimetal strip to bend, closing a contact after the required time delay.



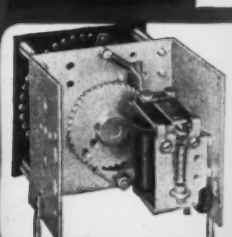
Series A-100 High Frequency

This A1SiMag insulated relay is compact, convenient, low in cost. In radio applications it is used for antenna changeover, break-in, high voltage keying, grid controlled rectifier keying, remote control of receiver and transmitter, and other high frequency applications.



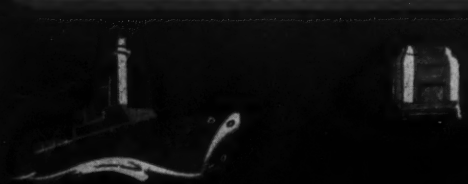
Series 120

The Series 120 is a small, compact relay. It is an economical unit designed for control needs which do not exceed single pole, double throw combination. Economy and simplicity of construction make it possible to offer the Series 120 at a low price compared with its high quality performance.



Series R Stepper

This Relay is built in three basic types for A.C. and D.C. operation: (1) Continuous rotation, (2) Electrical reset, (3) Add and subtract. Its principle application is automatic circuit selection including automatic sequence, automatic wave changing on short wave transmitters, automatic business machines, totalizing units, conveyer control.

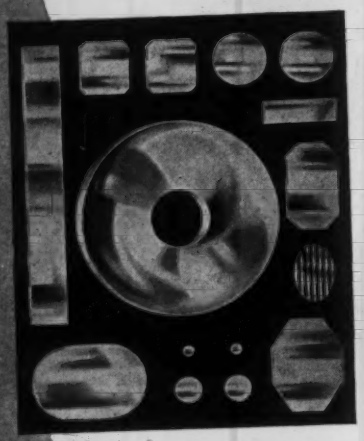


GUARDIAN ELECTRIC

1633 W. WALNUT STREET CHICAGO 12, ILLINOIS

Front or Rear Surface

MIRRORS AND REFLECTORS



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Front or Rear Surface Mirrors and Reflectors made to your specifications.

Closest optical and dimensional tolerances observed.

- EXCEPTIONAL REFLECTIVITY
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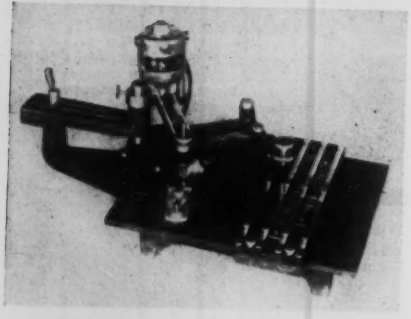

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Attachments adapt it to small or large work on flat or curved surfaces.

Excellent engraving can be produced by an inexperienced operator.

Widely used for production as well as occasional engraving.

Catalogue on request

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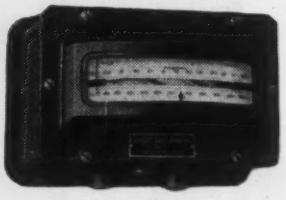
Wall-Type

INDICATOR PYROMETER

A PRODUCT OF 40 YEARS OF RESEARCH



Model W-1
Switchboard Indicator

Unskilled help may handle this direct-deflection instrument, which needs no manual adjustment. Designed for numerous ranges of temperature, both F. and C.

Write for descriptive Bulletin 400

Charles Engelhard, Inc.

233 N.J.R.R. Ave. Newark 5, N. J.

body with a thimble top. By turning thimble counter-clockwise, body rotates on ground micrometer 40 pitch threads, raising in increments of 0.001". Turning thimble clockwise lowers body. Range is ½" without extrusions and up to 2" with extrusions. Thimble has a compensating adjustment for thread wear. "Micro-Planer Gauge" comes complete with two extrusion bars and is packed in a protective wooden box. Dimensions: base 1¼" O.D.; body, ¾" O.D.; thimble, ⅞" O.D.; height, closed 1½"; extended, 2". — *Accurate Machine Products Co., 1640 So. Hobart Blvd., Los Angeles 6, Calif.*

Please mention number 941 when filling out card

Power Supplies for Instrument and Relay Testing

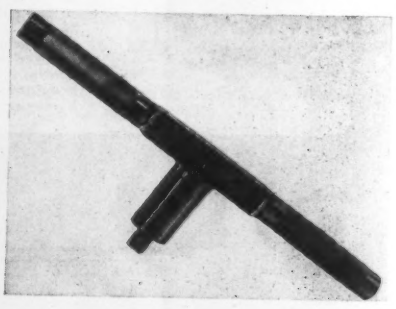
New packaged power supply units supply a smooth, variable power supply for routine testing and checking of relays and instruments. Output circuits of both a-c. and ripple-free d-c. are completely flexible as

to connections and uniformly variable over full range. New line includes alternating currents up to 20 amperes, a-c. voltages up to 800, direct currents up to 350 milliamperes, and d-c. voltages up to 400.—*Arthur E. Booth Co., 210 West Seventh Street, Los Angeles 14, Calif.*

Please mention number 942 when filling out card

Heavy-duty Torque Wrench

New "JOTE" T handle heavy-duty torque wrench has a range to 90 ft./lbs., is equipped with needle bearings to minimize



friction. Break comes by automatic impulse when predetermined torque has been reached. All torque control features are metal-encased to stand up under shop usage. Wrench is 10" long over-all, 3½" high, has a ½" square drive, and is chrome plated. Like maker's smaller wrench, it is pre-set at factory or in the tool crib. At present it is being manufactured with non-ratcheting action.—*JO Mfg. Co., South Gate, Calif.*

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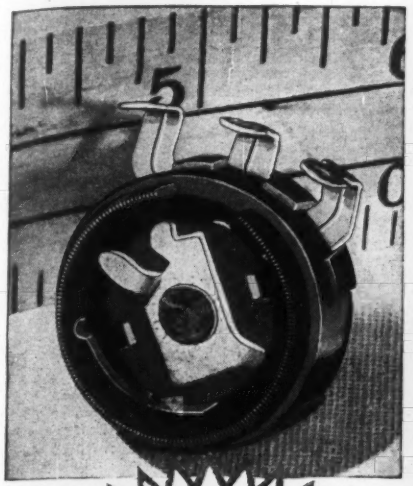

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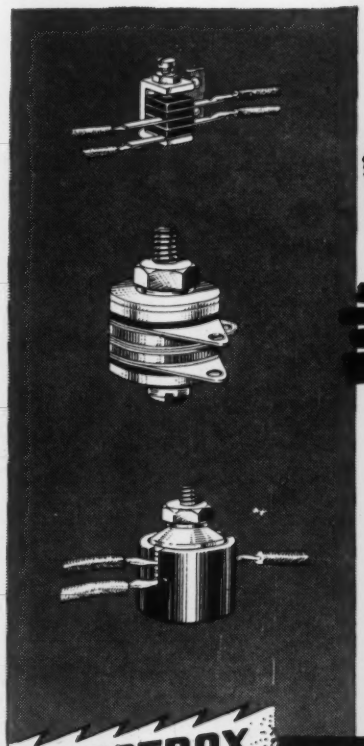

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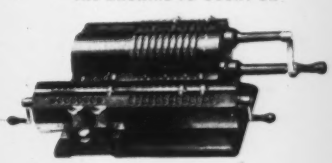

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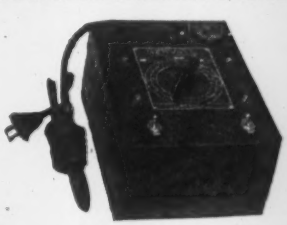

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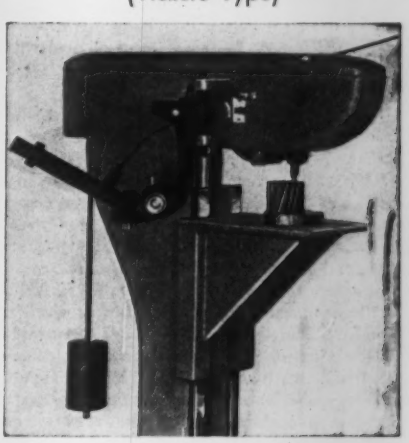

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RECENTLY *Instruments* has received a number of requests for information on the availability of books and pamphlets on measurement, inspection, testing and control. As a number of readers may be interested, the following list was prepared.

The books listed will be exhibited in Booth 14 at the "Instrumentation for Tomorrow" Exhibit on the 17th Floor of the William Penn Hotel, Pittsburgh, September 16-20, 1946.

As these books comprise the library of the Instruments Publishing Company a number of those listed are out of print—no longer available. In the following list, those items which do not mention price are *not* available at the present time. Recently a number of publishers have increased their prices and every effort has been made to include this information by sending checking copies of this list to the publishers for checking. The prices listed, of course, are subject to change without notice.

As some of the books and pamphlets published by instrument manufacturers have educational and reference value and are not primarily issued for sales promotion, many of these are included in the list. To be sure that all such literature was included, a letter was sent to instrument manufacturers advising them of our intention of publishing such a list. There may be several such not included because no information on these was made available.

AVIATION

AVIATION INSTRUMENT MANUAL. — Chemical Publishing Company, Brooklyn, N. Y., 1st American Edition, 1941. Cloth, 5½x6¾ inches, 396 pages.

NOMENCLATURE FOR AERONAUTICS—Report No. 474. NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS. Superintendent of Documents, Washington, 1933. Paper, 9x11⅜ inches, 37 pages. Price 10 cents.

AIRCRAFT INSTRUMENTS—Navy Training Courses—1945. Navpers 10333 U. S. Government Printing Office, Washington. Paper, 5¼x7¾ inches, 240 pages. Price 40c.

AIRCRAFT INSTRUMENTS — Technical Manual No. 1-413 War Department, Washington, 1942. Superintendent of Documents, Washington. Paper, 5½x8½ inches, 234 pages.

AIRPLANE INSTRUMENTS—By DANIEL J. BRIMM, JR. AND H. G. WINTERSTEEN. International Textbook Company, Scranton, Pa., 1943. Leatherette, 5x7⅝ inches, parts 1-2, 118 pages. Price $1.20.

AIRCRAFT SPEED INSTRUMENTS—By K. HILDING BEIJ. National Advisory Committee for Aeronautics. Report No. 420. Superintendent of Documents, Washington, 1941. Paper, 8½x10¾ inches, 59 pages. Price 20c.

METEOROLOGICAL GLOSSARY—Published by the AUTHORITY OF THE METEOROLOGICAL COMMITTEE. Chemical Publishing Co., Inc., New York, Third Edition, 1940. Cloth, 5½x8¾ inches, 251 pages.

THE COMPLETE AIR NAVIGATOR—By D. C. T. BENNETT. Sir Isaac Pitman & Sons, Ltd., London. Fourth Edition, 1942. Cloth, 5½x8¾ inches, 378 pages. Price $5.00.

METEOROLOGY—By WILLIAM ALEXANDER AND W. J. D. ALLAN. George Allen & Unwin Ltd., London, 1941. Paper, 4¼x6½ inches, 110 pages. Price 2/6.

DEAD RECKONING NAVIGATION—By W. J. D. ALLAN AND WM. ALEXANDER. George Allen & Unwin Ltd., London, 1942. Paper 4x6½ inches, 99 pages. Price $1.50.

RADIO NAVIGATION—By W. J. D. ALLAN. George Allen & Unwin Ltd., London, 1942. Paper, 4⅛x6½ inches, 111 pages. Price $1.50.

AIRCRAFT INSTRUMENTS—By W. J. D. ALLAN. Chemical Publishing Co., Inc., Brooklyn, N. Y., 1942. Cloth, 4¾x6¾ inches, 102 pages.

AERODYNAMICS AND FLIGHT—By JAMES ROSS ALLEN. International Textbook Co., Scranton, Pa., 1935. Leatherette, 5x7⅝ inches, 172 pages. Price $1.75.

ALTITUDE-PRESSURE TABLES BASED ON THE UNITED STATES STANDARD ATMOSPHERE—By W. G. BROMBACHER. National Advisory Committee for Aeronautics, Report No. 538. Superintendent of Documents, Washington, 1942. Paper, 8½x10¾ inches, 14 pages. Price 10c.

MEASUREMENT OF ALTITUDE IN BLIND FLYING—Technical Notes, National Advisory Committee for Aeronautics, No. 503. By W. G. BROMBACHER. National Advisory Committee for Aeronautics, Washington, 1934. Paper, 7¾x10¾ inches, 46 pages.

PRESSURE ELEMENT OF CONSTANT LOGARITHMIC STIFFNESS FOR TEMPERATURE COMPENSATED ALTIMETER—By W. G. BROMBACHER AND F. CORDERO. National Advisory Committee for Aeronautics, Report No. 310. Superintendent of Documents, Washington, 1929. Paper, 8⅝x10⅞ inches, 13 pages. Price 10c.

GYROSCOPIC INSTRUMENTS FOR INSTRUMENT FLYING—Technical Notes, National Advisory Committee for Aeronautics, No. 662. By W. G. BROMBACHER AND W. C. TRENT. National Advisory Committee for Aeronautics, Washington, 1938. Paper, 7¾x10¾ inches, 49 pages.

SPHEROGRAPHICAL NAVIGATION — By DIRK BROUWER, FREDERIC W. KEATOR AND D. A. MCMILLEN. Macmillan Company, New York, 1944. Cloth, 4½x7⅝ inches, 200 pages.

ASTRO-NAVIGATION—Part Four. By FRANCIS CHICHESTER. George Allen & Unwin Ltd., London, 1942. Paper, 4⅛x6½ inches, 151 pages. Price 2s.6d.

INSTRUMENT AND RADIO FLYING—By KARL S. DAY. Air Associates, Inc., Roosevelt Field, Garden City, N. Y., 1938. Cloth, 5½x8½ inches, 284 pages. Price $3.50.

PILOTS' AND MECHANICS' AIRCRAFT INSTRUMENT MANUAL—By G. C. DEBAUD. Ronald Press Company, New York, 1942. Cloth, 5¾x8⅝ inches, 490 pages. Price $4.50.

RADIO DIRECTION FINDERS—By DONALD S. BOND. McGraw-Hill Book Co., New York, 1944. Cloth, 5¼x8½ inches, 287 pages. Price $3.50.

CONSTRUCTION — MAINTENANCE AND REPAIRING OF AIRCRAFT INSTRUMENTS (Reprint)—By J. A. GORDON. Henry Paulson & Co., Chicago. Paper, 7x10 inches, 29 pages.

METEOROLOGY FOR PILOTS—Civil Aeronautics, Bulletin No. 25. By B. C. HAYNES. U. S. Department of Commerce, Washington, 1940. Paper, 6½x9½ inches, 167 pages.

A METHOD FOR THE DYNAMIC CALIBRATION OF ACCELEROMETERS—National Advisory Committee for Aeronautics, Misc. Paper No. 47. By JAMES A. HOOTMAN. National Advisory Committee for Aeronautics, Washington, 1942. Paper, 8x10½ inches, 6 pages.

INVESTIGATION OF DAMPING LIQUIDS FOR AIRCRAFT INSTRUMENTS—II—By M. R. HOUSEMAN AND G. E. KEULEGAN. National Advisory Committee for Aeronautics, Report No. 398. Superintendent of Documents, Washington, 1931. Paper, 8½x10¾ inches, 19 pages. Price 15c.

AIRCRAFT INSTRUMENTS—By GEORGE ELLIS IRVIN. McGraw-Hill Book Company, New York, Second Edition, 1944. Cloth, 5¼x8½ inches, 607 pages. Price $6.00.

AIRCRAFT RATE-OF-CLIMB INDICATORS—By DANIEL P. JOHNSON. National Advisory Committee for Aeronautics, Report No. 666. Superintendent of Documents, Washington, 1939. Paper, 8½x10¾ inches. 10 pages. Price 10c.

THROUGH THE OVERCAST—By ASSEN JORDANOFF. Funk & Wagnalls Company, New York, 1938 (Rev. 1943). Cloth, 7¼x9¾ inches, 356 pages. Price $3.00.

NAVIGATION—By L. M. KELLS, W. F. KERN AND J. R. BLAND. McGraw-Hill Book Co., Inc., New York, First Edition, 1943. Cloth, 5¾x9 inches, 479 pages. Price $5.50.

INVESTIGATION OF DAMPING LIQUIDS FOR AIRCRAFT INSTRUMENTS—By G. H. KEULEGAN. National Advisory Committee for Aeronautics, Report No. 299. Superintendent of Documents, Washington, 1929. Paper, 8½x10¾ inches, 24 pages. Price 10c.

HANDBOOK OF AIRPLANE INSTRUMENTS. Kollsman Instrument Division of Square D Co., Elmhurst, N. Y., 1940. Binder, 8½x11 inches. Price $2.00.

AIR NAVIGATION FOR BEGINNERS—Second Edition—By SCOTT G. LAMB. Norman W. Henley Publishing Co., New York, 1943. Cloth, 5⅜x8 inches, 101 pages. Price $1.50.

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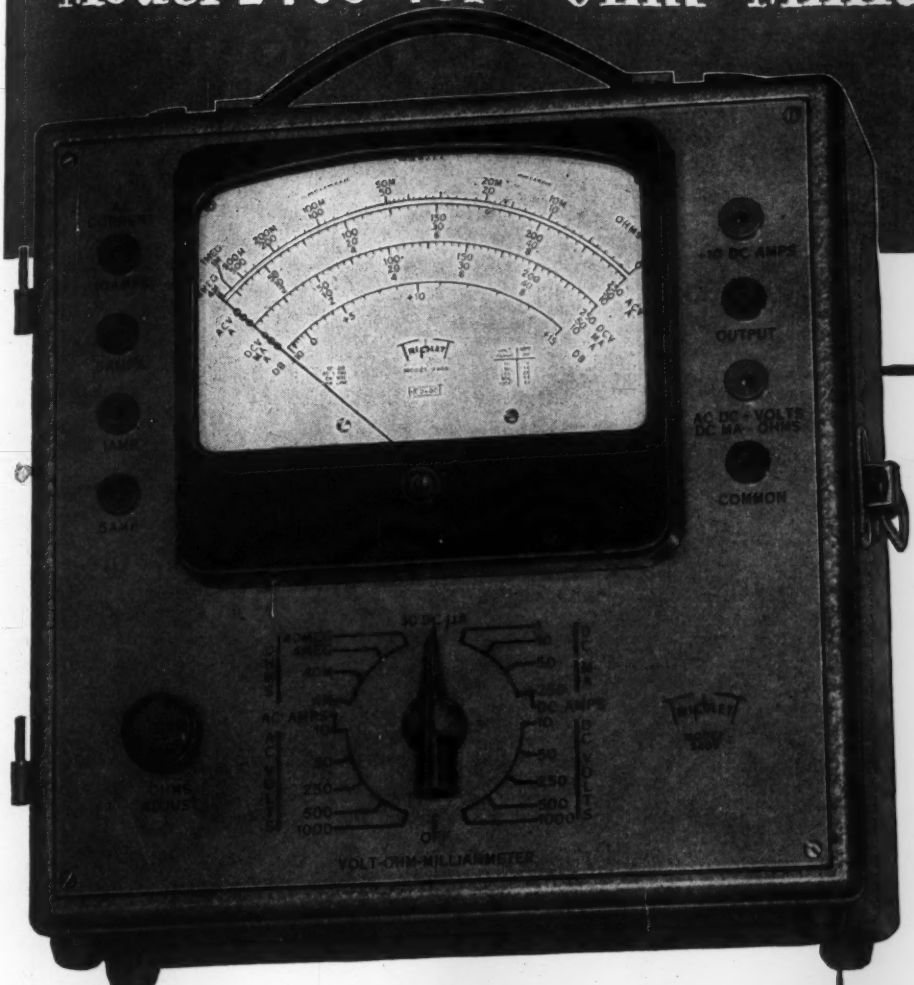

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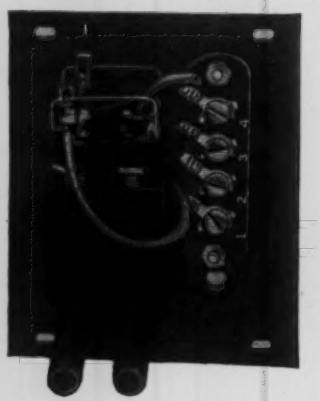

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Aeronautics Bulletin No. 24.—By THOBURN C. LYON. U. S. Department of Commerce, Washington, 1940. Paper, 6½x9½ inches, 245 pages.

THE CAA-RTCA INSTRUMENT LANDING SYSTEM TESTS AND MODIFICATIONS—Part II—By HENRY I. METZ. U. S. Department of Commerce, Civil Aeronautics Administration, Washington, D. C., 1943. Paper, 8x10½ inches, 27 pages.

METEOROLOGICAL INSTRUMENTS — By W. E. KNOWLES MIDDLETON. University of Toronto Press, Toronto, Second Edition, 1943. Cloth, 6½x9⅞ inches, 227 pages. Price $3.25.

AEROPLANE INSTRUMENTS—By E. MOLLOY. Chemical Publishing Co., Inc., Brooklyn, 1941. Cloth, 5½x8¾ inches, Part I, 132 pages; Part II, 132 pages.

AIRCRAFT INSTRUMENTS—Their Theory, Function and Use.—By ORION EDWARD PATTON. D. Van Nostrand Co., Inc., New York, 1941. Cloth, 6x9¼ inches, 220 pages. Price $2.75.

AIRCRAFT COMPASS CHARACTERISTICS—By JOHN B. PETERSON AND CLYDE W. SMITH. National Advisory Committee for Aeronautics Report No. 551. Superintendent of Documents, Washington, 1936. Paper, 8½x10¾ inches, 11 pages. Price 10c.

FUNDAMENTALS OF AVIATION—By NORMAN POTTER AND WILLIAM J. KONICEK. Link Aviation Devices, Inc., Binghamton, N. Y., 1945. Paper, 8½x11 inches, 107 pages. Price $1.00.

THE THEORY OF THE GYROSCOPIC COMPASS AND ITS DEVIATIONS—By A. L. RAWLINGS. Macmillan Company, New York, Second Edition 1944. Cloth, 5½x8⅝ inches, 182 pages. Price $3.00.

INSTRUMENT FLYING AND RADIO NAVIGATION—By HOLLAND L. REDFIELD. Ronald Press Co., New York, 1944. Cloth, 5½x8¼ inches, 195 pages. Price $3.00.

AIR TRANSPORT NAVIGATION — By PETER H. REDPATH AND JAMES M. COBURN. Pitman Publishing Corp., New York, 1943. Cloth, 6x9¼ inches, 612 pages. Price $5.50.

AIRCRAFT INSTRUMENTS — Their Construction and Maintenance—By J. RILEY. Henry Paulson & Co., Chicago, Ill. Paper, 4⅞x7¼ inches, 74 pages.

AIRCRAFT POWER-PLANT INSTRUMENTS—By HARCOURT SONTAG AND W. G. BROMBACHER. National Advisory Committee for Aeronautics Report No. 466. Superintendent of Documents, Washington, 1941. Paper, 8½x10¾ inches, 57 pages. Price 20c.

METHOD OF TESTING OXYGEN REGULATORS—Technical Notes, National Advisory Committee for Aeronautics, No. 532—By HARCOURT SONTAG AND E. L. BORLIK. National Advisory Committee for Aeronautics, Washington, 1935. Paper, 7¾x10¼ inches, 9 pages.

PERFORMANCE CHARACTERISTICS OF VENTURI TUBES USED IN AIRCRAFT FOR OPERATING AIR-DRIVEN GYROSCOPIC INSTRUMENTS—Technical Notes, National Advisory Committee for Aeronautics, No. 624.—By HARCOURT SONTAG AND DANIEL P. JOHNSON. National Advisory Committee for Aeronautics, Washington, 1937. Paper, 7¾x10¼ inches, 27 pages.

A START IN METEOROLOGY — Second Edition Revised—By ARMAND N. SPITZ. Norman W. Henley Publishing Co., N. Y., 1943. Cloth, 5⅜x8 inches, 93 pages. Price $1.50.

AIRCRAFT INSTRUMENTS—By EMANUELE STIERI. Duell, Sloan and Pearce, New York, 1943. Cloth, 4x6¼ inches, 312 pages. Price $1.50.

EFFECT OF AGING ON TAUT RUBBER DIAPHRAGMS—Technical Notes, National Advisory Committee for Aeronautics, No. 409.—By D. H. STROTHER AND H. B. HENDRICKSON. National Advisory Committee for Aeronautics, Washington, 1932. Paper, 7⅞x10¼ inches, 14 pages.

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CORRUGATED METAL DIAPHRAGMS FOR AIRCRAFT PRESSURE-MEASURING INSTRUMENTS—Technical Notes, National Advisory Committee for Aeronautics, No. 738. By W. A. WILDHACK and V. H. GOERKE. National Advisory Committee for Aeronautics, Washington, 1939. Paper, 7¾x10¼ inches, 41 pages.

AIR NAVIGATION — Parts 1-2 — By H. G. WINTERSTEEN. International Textbook Company, Scranton, Pa., 1943. Leatherette, 5x7⅝ inches, 106 pages. Price $1.25.

RADIO AND INSTRUMENT FLYING INSTRUCTOR MANUAL—By CHARLES A. ZWENG and ALLAN C. ZWENG. Pan American Navigation Service, North Hollywood, California, Fourth Edition, 1943. Paper, 6¾x10 inches, 252 pages. Price $4.00.

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GRUNDLAGEN UND GERAETE TECHNISCHER LAENGENMESSUNGEN—By G. BERNDT. Verlag Julius Springer, Berlin, Second Edition, 1929. Cloth, 6¾x10 inches, 374 pages.

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GAGES AND THEIR USE IN INSPECTION—First Edition. By FRED H. COLVIN. McGraw-Hill Book Co., Inc., New York, 1942. Cloth, 4¾x7½ inches, 157 pages. Price $1.50.

SAWING MACHINES—PRECISION SAWING AND FILING METHODS—DoAll Company, Minneapolis, Minn., 1945. Cloth, 6x9 inches, Vol. 1, 263 pages.

PROGRESS IN PRECISION—SCIENCE OF MEASUREMENT—DoAll Trade School, Des Plaines, Ill., 1945. Paper, 6x9 inches, Book 1, 24 pages; Book 2, 20 pages; Book 3, 24 pages; Book 4, 20 pages; Book 5, 28 pages; Book 6, 28 pages; Book 7, 48 pages; Book 8, 28 pages.

DIMENSIONAL QUALITY CONTROL PRIMER. Federal Products Corporation, Providence, R. I. Paper, 5½x8¾ inches, 39 pages.

GAGES, JIGS, AND FIXTURES—By EDWARD GRIFFITHS. International Textbook Co., Scranton, Pa., 1939. Leatherette, 5x7⅝ inches, 224 pages. Price $2.25.

PRECISION MEASUREMENT IN THE METAL WORKING INDUSTRY—INTERNATIONAL BUSINESS MACHINES CORP., 1942. Available from Syracuse University Press, Syracuse, N. Y. Cloth, 8x11 inches; Vol. I, 263 pages; Vol. II, 290 pages. Price $2.75.

ENGINEERING PRECISION MEASUREMENTS—By A. W. JUDGE. Chapman & Hall, Ltd., London, 1944. Cloth, 5½x8¾ inches, 310 pages. Price 25/.

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ESSENTIALS OF PRECISION INSPECTION — By WESLEY MOLLARD. McGraw-Hill Book Co., Inc., New York, 1944. Cloth, 8½x11¼ inches, 207 pages. Price $3.50.

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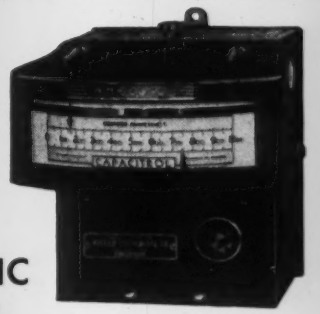

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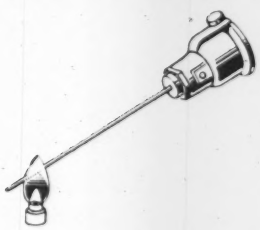

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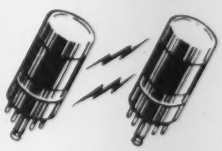

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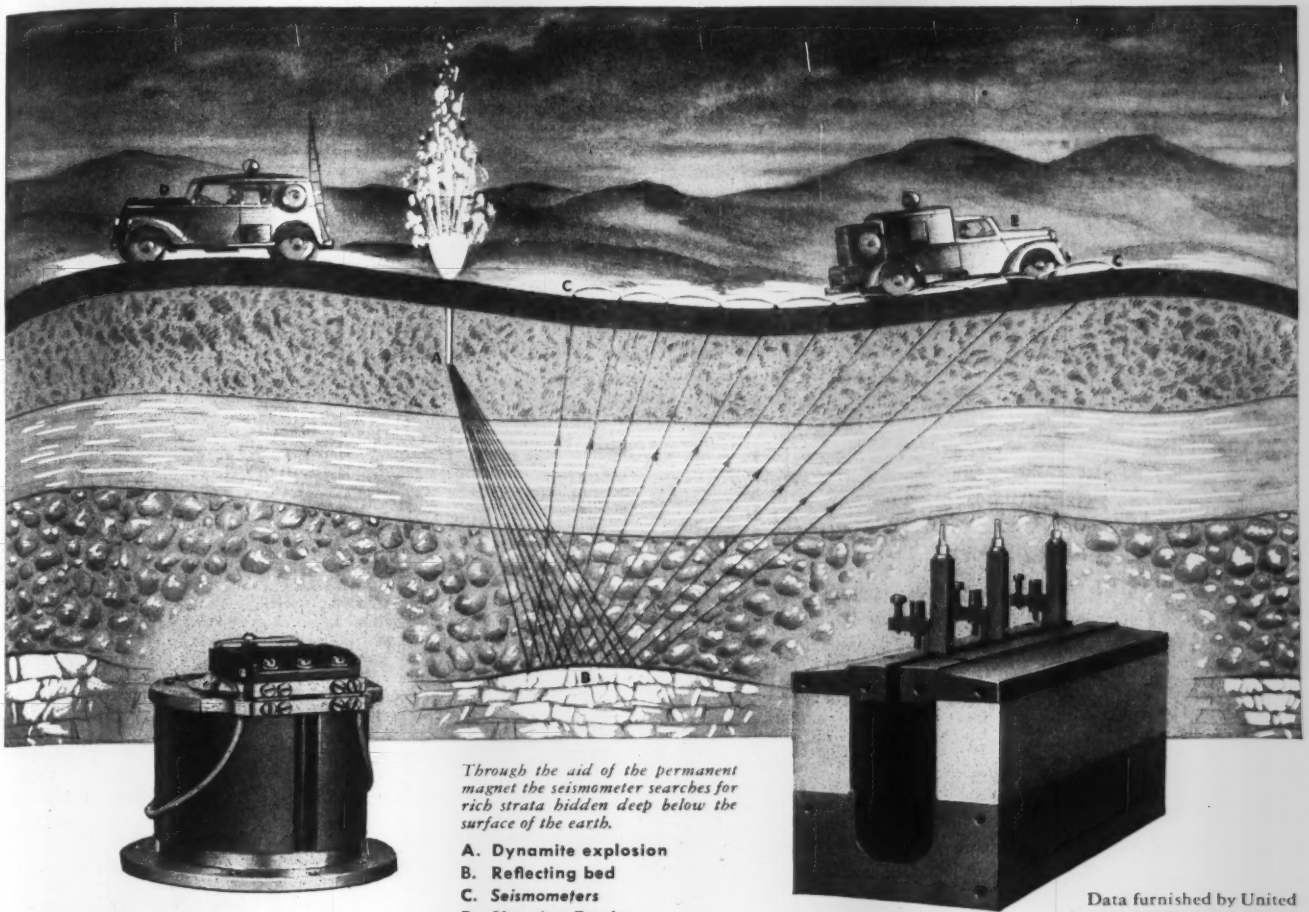

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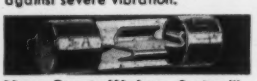

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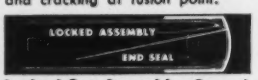

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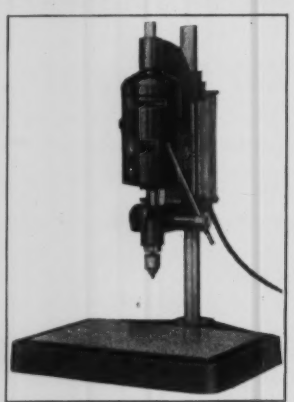

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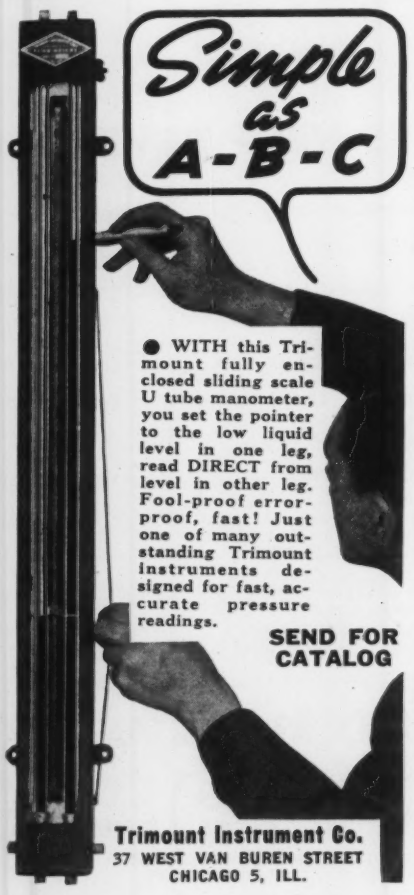
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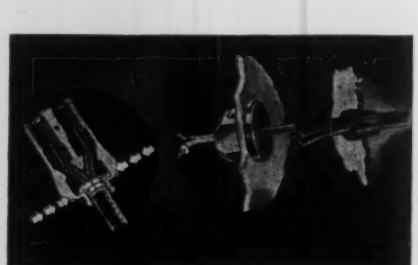

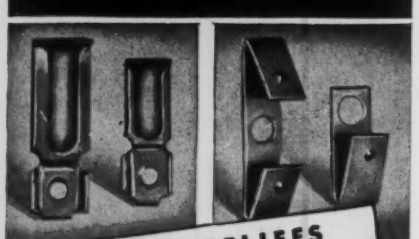

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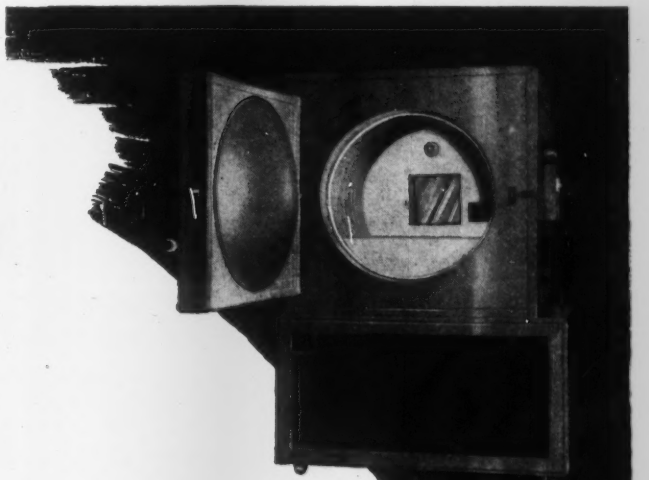

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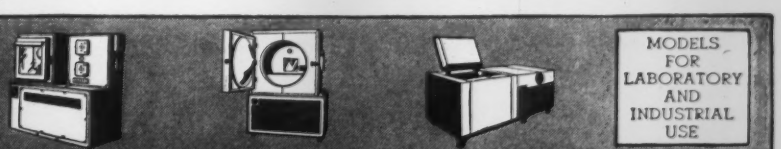

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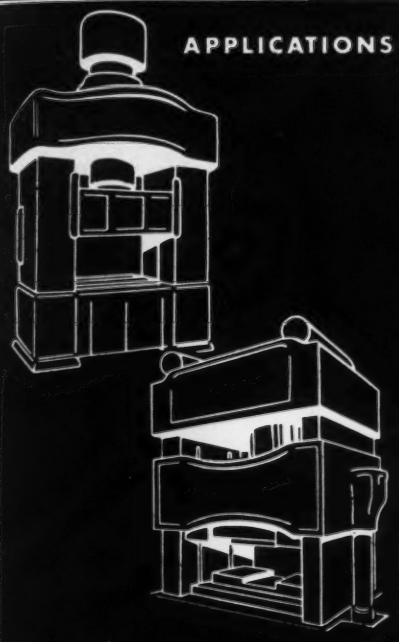

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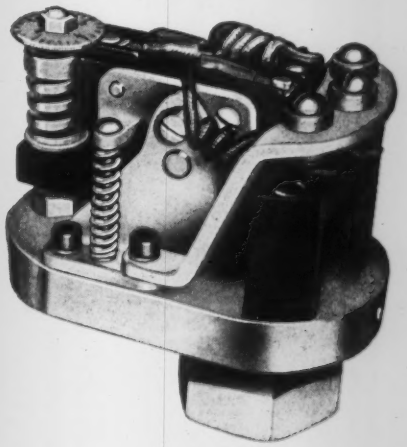

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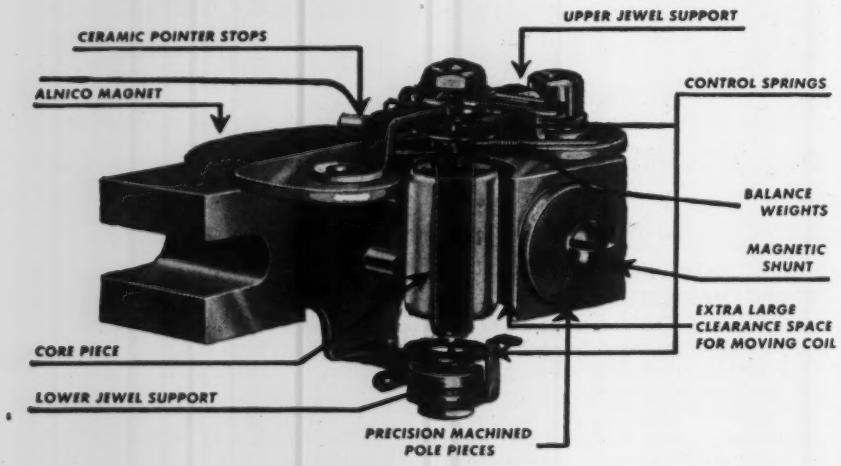

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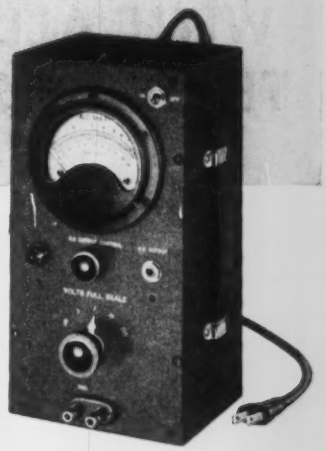

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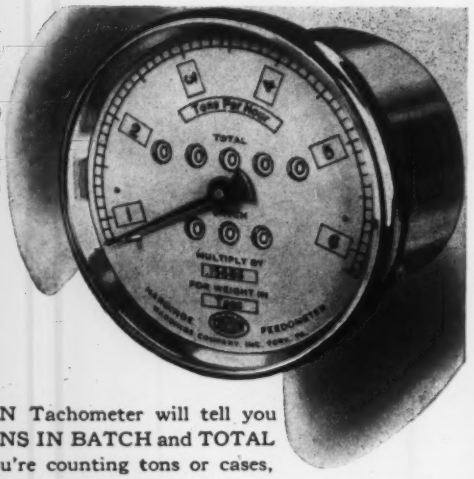

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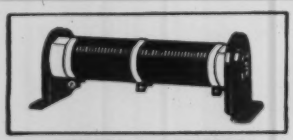

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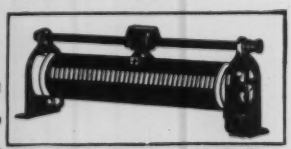

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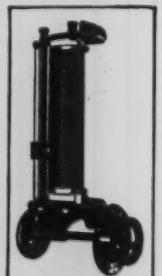

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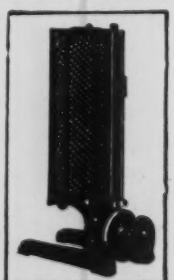

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PHYSICAL TESTING

MECHANICAL TESTING—By R. G. BATSON and J. H. HYDE. E. P. Dutton & Co., New York, 1931. Cloth, 5⅝x8⅜ inches, Vol. I, 465 pages; Vol. II, 446 pages.

STATIC AND DY-NAMIC BALANCING—Bear Manufacturing Company, Rock Island, Ill. Paper, 8½x11 inches, 16 pages.

CONTROL OF SURFACE QUALITY—By JAMES A. BROADSTON. Surface Checking Gage Co., Hollywood, Calif., Second Edition, 1945. Binder, 5x7 inches, 59 pages. Price $8.00.

PHYSICAL TESTING OF METALS AND INTERPRETATION OF TEST RESULTS—By H. D. CHURCHILL. American Society for Metals, Cleveland, 1936. Cloth, 6x9¼ inches, 109 pages. Price $2.00.

ENGINEERING MATERIALS AND PROCESSES—By WM. HOWARD CLAPP and DONALD SHERMAN CLARK. International Textbook Company, Scranton, Pa., 1st Edition, 1938. Leatherette, 5¼x8½ inches, 543 pages. Price $4.50.

PRINCIPLES OF MAGNAFLUX INSPECTION—By F. B. DOANE. Photopress, Inc., Chicago, Second Edition, 1941. Leatherette, 6x9¼ inches, 288 pages. Price $2.50.

MAGNAFLUX AIRCRAFT INSPECTION MANUAL—By F. B. DOANE and W. E. THOMAS. Photopress, Inc., Chicago, Second Edition, 1941. Cloth, 6x9¼ inches, 193 pages. Price $1.75.

THE MECHANICAL TESTING OF METALS AND ALLOYS—By J. FIELD FOSTER. Sir Isaac Pitman & Sons, Ltd., London, Third Edition, 1942. Cloth, 5½x8¾ inches, 317 pages. Price $5.00.

MATERIALS TESTING MACHINES—By C. H. GIBBONS. Instruments Publishing Company, Pittsburgh, 1935. Cloth, 5x8 inches, 89 pages. Price $1.00.

STRENGTH OF MATERIALS—By HARVEY F. GIRVIN. International Textbook Company, Scranton, Pa., First Edition, 1944. Leatherette, 6x9 inches, 357 pages. Price $3.50.

DYNAMIC AND STATIC BALANCE CORRECTION AND HOW TO ELIMINATE VIBRATION—Bulletin 200A. Globe Tool & Engineering Co., Dayton, Ohio. Paper, 5⅜x7⅝ inches, 12 pages.

STRENGTH OF MATERIALS—International Textbook Company, Scranton, Pa., 1944. Cloth, 5x7⅝ inches, 224 pages. Price $2.50.

ENGINEERING MATERIALS—By ARTHUR W. JUDGE. Isaac Pitman & Sons, New York City, 1929. Cloth, 5½x8½ inches, Vol. I, 683 pages, price $7.50; Vol. III, 498 pages. Price $8.50.

HARDNESS—By D. LANDAU. Nitralloy Corporation, New York City, First Edition, 1943. Paper, 6x9 inches, 105 pages.

FAULT LOCATION IN CABLES—Note Book E-53-441. Leeds & Northrup Company, Philadelphia, 1943. Paper, 5¼x7¾ inches, 52 pages.

MATERIALPRUEFUNG UND BAUSTOFFKUNDE FUER DEN MASCHINENBAU—By WILLY MUELLER. Verlag R. Oldenbourg, Berlin, 1924. Paper, 6¼x9½ inches, 370 pages.

WERKSTOFFPRUEFUNG (METALLE)—

By P. RIEBENSAHM. Verlag Julius Springer, Berlin, 1936. Paper, 6x9 inches, 65 pages.

MECHANICAL TESTS FOR ENGINEERING MATERIALS—Session 1935-36. By A. M. ROBERTS. Draughtsman Publishing Co., Ltd., London. Paper, 5½x8⅜ inches, 89 pages.

GENERAL TESTING METHODS AND TABLES FOR MINERAL OILS—By W. A. C. SCHLUETER. Refinery Supply Co., Tulsa, Okla., 1920. Cloth, 4¾x6⅜ inches, 99 pages.

THE STARRETT BOOK FOR STUDENT MACHINISTS. The L. S. Starrett Company, Athol, Mass., 1941. Cloth, 4¾x7⅛ inches, 184 pages. Price 75c.

A MANUAL IN THE TESTING OF MATERIALS—By HARRY TUCKER. International Textbook Company, Scranton, Pa., First Edition 1937. Leatherette, 6x9 inches, 283 pages. Price $3.00.

PRECISION MEASURING TOOLS—Catalog and Handbook No. 33. The Van Keuren Company, Watertown, Mass., 1945. Leatherette, 6x9⅛ inches, 160 pages.

QUALITY CONTROL—A Handbook of Scientific Inspection—By ROBERT J. WILKIE and JOHN A. HARRINGTON. The DoAll Company, Minneapolis, Third Edition, 1945. Leatherette, 6x9¼ inches, 140 pages.

HARDNESS AND HARDNESS MEASUREMENTS—By SAMUEL R. WILLIAMS. American Society for Metals, Cleveland, 1942. Cloth, 6x9¼ inches, 558 pages. Price $7.50.

RADIO

TESTING RADIO SETS—By J. H. REYNER. Chapman & Hall, Ltd., London, Fourth Edition, 1944. Cloth, 5½x8¾ inches, 215 pages. Price 15 shillings.

DICTIONARY OF RADIO AND TELEVISION TERMS—By RALPH STRANGER. Chemical Publishing Co., Inc., Brooklyn, 1941. Cloth, 5½x6¾ inches, 252 pages.

SUPERSONICS

DER ULTRASCHALL UND SEINE ANWENDUNG IN WISSENSCHAFT UND TECHNIK—By LUDWIG BERGMANN. VDI—Verlag GMBH, Berlin, 1942. Available from Edwards Brothers, Inc., Ann Arbor, Mich. Cloth, 5½x8½ inches, 445 pages. Price $9.50.

ULTRASONICS AND THEIR SCIENTIFIC AND TECHNICAL APPLICATIONS—By LUDWIG BERGMANN, translated by H. Stafford Hatfield. John Wiley & Sons, Inc., New York. Cloth, 5½x8¾ inches, 264 pages. Price $4.50.

SURVEYING

ELEMENTARY SURVEYING—By WARREN C. TAYLOR. International Textbook Company, Scranton, Pa., First Edition, 1939. Leatherette, 4½x7⅜ inches, 236 pages. Price $2.25.

ELEMENTS OF PHOTOGRAMMETRY—By GEORGE D. WHITMORE. International Textbook Company, Scranton, 1941. Leatherette, 5x7⅝ inches, 136 pages. Price $1.75.

GEODETIC SURVEYING—By GEORGE D. WHITMORE. International Textbook Company, Scranton, 1942. Leatherette, 4¾x7⅝ inches, 285 pages. Price $3.00.

ESSENTIALS OF AERIAL SURVEYING AND PHOTO INTERPRETATIONS—By TALBERT A. ABRAMS. McGraw-Hill Book Company, New York, First Edition, 1944. Cloth, 5x7⅝ inches, 289 pages. Price $3.25.

ENGINEERING APPLICATIONS OF AERIAL AND TERRESTRIAL PHOTOGRAMMETRY—By B. B. TALLEY. Pitman Publishing Corp., New York, 1938. Cloth, 6x9¼ inches, 612 pages. Price $10.00.

WEIGHING

WEIGHTS AND MEASURES ADMINISTRATION *(No. 11 of the Handbook Series of the Bureau of Standards)*. Superintendent of Documents, Government Printing Office, Washington, 1927. Cloth, 5x7⅝ inches, 270 pages. Price 70c.

WEIGHTS AND MEASURES—*Report of the 26th National Conference (Miscellaneous Publication M157 National Bureau of Standards.)* Government Printing Office, Washington, D. C., 1937. Paper, 5¾x9⅛ inches, 166 pages. Price 20c.

STANDARDS OF WEIGHT AND MEASURE—Price List 64. Superintendent of Documents, Washington, 24th Edition, 1937. Paper, 5⅛x9 inches, 88 pages.

DIE WAAGE IM WANDEL DER ZEITEN—By AUGUST KRUHM, W. Kramer & Co., Frankfurt, Germany, 1934. Paper, 6x8¾ inches, 32 pages.

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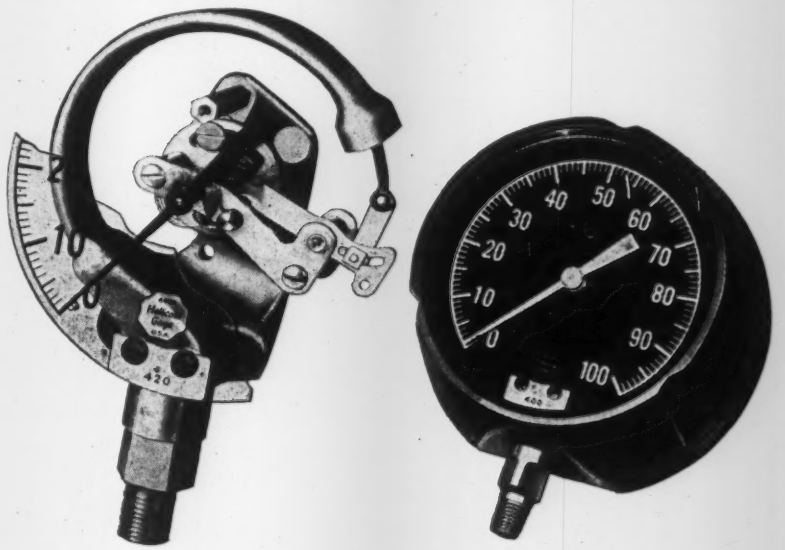

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SOCIETY OF AMERICA

For the *big* ISA news: the "Instrumentation for Tomorrow" Conference and Exhibit, see the Program Supplement in this issue following page 512.

CHICAGO

The next meeting of the Chicago Section, I.S.A., will be held at the Merchants and Manufacturers Club on Monday, Oct. 7. The speaker will be William B. Warren, of Los Angeles, Cal., who will talk on "Applications of the Unbonded Resistance Gage." Hugh E. Ferguson, of the Peoples Gas Light & Coke Co., Chicago, will be Technical Chairman.

—A. J. BUTLER, *Sec'y*

CUMBERLAND

The new officers and committee chairmen of the Cumberland Section, I.S.A., are as follows: President, Robert N. Wilson; Secretary-Treasurer, Carl A. Lower; Program and Publicity Committee Chairman, Harold E. Bishop; Membership Committee Chairman, Karl Taschenberger; Nominating Committee Chairman, Clyde Babst. The Executive Board is comprised of the President, Secretary-Treasurer and Committee Chairmen. —CARL A. LOWER, *Secretary*

PITTSBURGH

The next meeting of the Pittsburgh Section ISA will be held at the Roosevelt Hotel on Monday, October 28th. Dinner will be at 6:30 and the meeting will start at 8:00. Speaker for the evening will be A. A. Hejduk of the Meriam Instrument Co., Cleveland, whose talk will be entitled, "Manometer Applications in Industry."

—L. M. SUSANY, *Sec'y*

Other Societies

AKRON INSTRUMENT SOCIETY

The Akron Instrument Society will resume meetings after the summer recess with a dinner meeting at Riley's Tavern on Tuesday, September 24th. The speaker for this meeting will be Mr. Kermit Fischer, of Fischer and Porter Company, whose subject will be, "The Theory of the Rotameter and its Practical Applications."

Our society is looking forward confidently to its first full year, having been organized only last February. In this short time we have built up a membership of 70, with 56 more who have indicated their intention of becoming members. An active Lecture Committee has lined up excellent speakers and subjects for the entire year.

A cordial invitation is extended to all those interested in instruments and instrumentation to become members of our Society. —FRED APPEL, JR., *Secretary*

OAK RIDGE INSTRUMENT SOCIETY

At the August meeting of the Oak Ridge Instrument Society the following officers for year 1946-47 were elected: President, A. V. Novok; Vice-President, W. J. Greter; Secretary, A. H. Fowler; Treasurer, D. M. Boyd; Executive Councillors, H. V. Fisher, R. E. Mitchell, and Jack Mahoney.

Following the election Mr. D. M. Boyd gave a very interesting talk on the development of oil refinery instrumentation from the earliest plants to the modern catalytic cracking plants.

The first annual business meeting and dinner will be held September 3, 1946 at 7:00 P. M. in Grove Hall.

Mr. Lawrence Dysart, engineer from Fulton Sylphon Co., Knoxville, Tennessee, will be guest speaker.

—A. H. FOWLER, *Sec'y*

N. Y. SECTION AIChE HOLDS INSTRUMENTATION SYMPOSIUM

The New York Section of the American Institute of Chemical Engineers will hold an "Instrumentation and Process Control Symposium" on Thursday, October 17, 1946, afternoon and evening, at the Hotel Pennsylvania, New York, N. Y.

Registration will be at 12:30 P.M., Meeting — 1:30 P.M., Dinner — 6:30 P.M. The program follows:

1. "Underlying Principles of Instrumentation and Process Control," Ed S. Smith, Eclipse-Pioneer Division, Bendix Aviation Corporation.

2. "Some Factors Affecting a Controllable Process," J. C. Peters, Leeds & Northrup Company.

3. "Designing a Controllable Distillation Process," Dr. J. A. Patterson, Publiker Industries, Inc.

4. "Instrumentation and Plant Design," F. H. Trapnell, E. I. duPont de Nemours and Co.

5. "New Developments in Instrumentation," H. D. Middel, General Electric Company.

The dinner speaker will be E. S. Lee of the General Electric Company whose subject will be "Philosophy of Measurements."

The fee will be $6.00 for registration and dinner or $2.00 for registration only. Those wishing to attend are requested to preregister by letter or phone before October 11, 1946 with: G. K. Hickin, American Cyanamid Company, 30 Rockefeller Plaza, New York 20, N. Y., Telephone—CIrcle 7-0100—Ext. 254.

—G. K. HICKIN

TEXAS A. & M. OFFERS SHORT COURSE ON INSTRUMENTS

The Agricultural and Mechanical College of Texas, at College Station, Texas, will offer their first short course on "Instrumentation for the Process Industries" on September 4, 5 and 6, 1946. The course will be conducted as a seminar with lectures and discussions on the subject of automatic control. Cooperating with Texas A. & M. in the presentation of this course will be many industrial concerns manufacturing oil, gas, and chemical products. Manufacturers of instruments and automatic controls, likewise, are taking part by arranging to show educational exhibits, and provide capable lecturers for many of the sessions.

The program will cover a wide variety of subjects making it of value to anyone who uses such instruments, especially to instrument, process design and operating engineers. Problems of instrument maintenance will not be covered specifically in the lectures, but ample opportunity for the consideration of such problems will be provided in the discussion periods. The lectures will cover the subjects of measurement and control of temperature, pressure and liquid level, time control, and other allied subjects. The relationship between practice and basic control theory will be stressed.

NACA POSITIONS OPEN

The National Advisory Committee for Aeronautics at Langley Field, Virginia, has openings for engineers and technicians to work on the design, development and application of instruments for use in its wind tunnels and other aeronautical research facilities.

The Instrument Research Division at Langley Field has modern equipment and laboratory and shop facilities for work on mechanical, electrical, electronic and optical instrumentation. Inasmuch as its efforts are devoted to advancing the frontiers of aeronautical science, the highest standards of accuracy and performance must be maintained and the instrumentation must be of most advanced design. Currently, a large portion of the instrumentation is devoted to speeds considerably greater than the speed of sound and to the development of pilotless aircraft and guided missiles.

There are openings for professional men ranging from a starting rate of $2644.80 per annum for men just out of college to $4902 per annum for men with experience in instrument mechanics and instrument makers, ranging from $2034 per annum for men who have had a minimum of two years of experience, other than routine production, in construction, test, installation or maintenance of mechanical, electrical, electronic or optical instruments to a $3090 per annum starting rate for first class journeymen.

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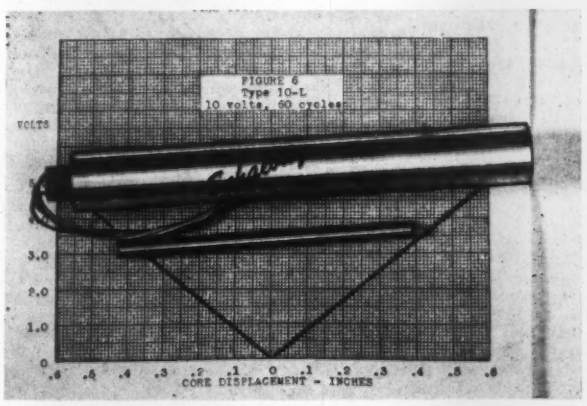

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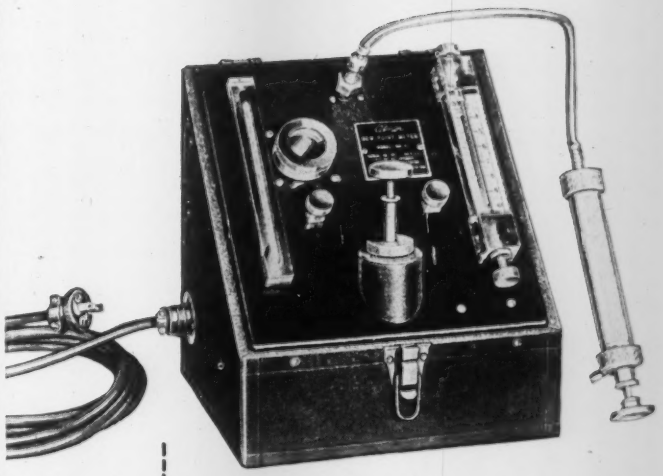

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Manufacturers' New Literature

In this department we report new literature pertaining to Instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on page 575.

N-369 **Appliance Temperature Tester.** 2-page 8½" × 11" Bulletin JRT-546 illustrates and describes Model "60-JRT" appliance temperature tester for checking operating temperatures of all types of refrigeration, gas and electric ranges. Instrument shows changes as they occur and compensates for room temperature, reads a. c. line power to 300 volts. J.B.T. Instruments Inc., New Haven 8, Conn.

N-370 **Insulation Resistance Tester.** 2-page 8½" × 11" folder Form IRTB illustrates and describes "Ideal" insulation resistance tester for checking a. c. or d. c. electrical equipment and having a range from 0 to 100 megohms. Instrument is entirely self-contained. Ideal Industries, Inc., Sycamore, Ill.

N-371 **Universal Rotameter.** 4-page 8½" × 11" bulletin pictures and describes the "SK Universal Rotameter." Instrument has universal end-fittings that provide for 25 different piping hook-ups, can be turned to permit horizontal connections exactly 90° apart and may be installed in vertical pipe lines. Tube may be cleaned without taking meter or tube from pipe line. Schutte & Koerting Co., Philadelphia 22, Pa.

N-372 **Automatic Linear Dividing Machines.** 20-page 8½" × 11" Bulletin 153-64, describes and illustrates company's newly expanded line of precision and production machines for rapid automatic ruling of linear scales in either the inch or metric system. The more common line patterns are illustrated and a table lists the extensive variety of spacings obtainable. Detailed specifications are included. The Gaertner Scientific Corporation, 1201 Wrightwood Avenue, Chicago 14, Illinois.

N-373 **Darkfield Quebec Colony Counter.** 4-page 7" × 10" Bulletin M-84 pictures and describes maker's improved colony counter which reveals colonies of bacteria clearly against a dark background. Illumination is uniform showing smaller colonies and assists in distinguishing colonies from other structures without glare. Wolffhuegel, Stewart and Jeffers plates are available. American Optical Co., Buffalo 15, New York.

N-374 **Hand Tachometer.** 2-page 8½" × 11" folder illustrates and describes O-Z hand tachometers with rotating gear shift and quintuple range. Instrument indicates accurately without timing or calculation, (1) r.p.m. right or left of shaft and spindles; (2) surface or peripheral speeds in f.p.m. right or left of pulleys, belts and drums; (3) speed variations in fraction of a revolution; (4) belt slipping. O. Zernickow Co., 15 Park Row, New York 7, N. Y.

N-375 **Turn and Bank Indicator Tester.** 2-page 8½" × 11" catalog sheet illustrates and describes maker's 4-speed turn and bank indicator tester with test rates of 90°, 180°, 360° and 1080° per minute. Instrument mounting carriage is provided with quick action spring clamps avoiding necessity of screw mounting and additional carriages can be mounted one above another to hold 4 or 6 instruments at one time. Ideal Laboratory Tool & Supply Co., Cheyenne, Wyo.

N-376 **Supersonics.** Single-sheet 8½" × 11" bulletin discusses supersonics in general terms, briefly describes three methods of wave-generation. G. C. Wilson & Co., 2 North Passaic Ave., Chatham, N. J.

N-377 **Photoelectric Colorimeter for Nessler Tubes.** 30-page 8½" × 11" bulletin pictures and describes "Model 450 Lumatron" photoelectric colorimeter for Nessler tubes. Instrument is designed especially for water analysis and any other tests requiring the accurate measurement of faint colorations and turbidities. Photovolt Corporation, 95 Madison Ave., New York 16, N. Y.

N-378 **Megohm Meter.** 8½" × 11" catalog sheet illustrates and describes maker's "Model 1500" for measurement of leakage resistance of insulating materials, condensers, coaxial cables, wiring harness, motor and transformer windings. Tester may also be used for production checking of resistors and for moisture content determinations of wood, textiles, etc. Communications Measurements Laboratory, 120 Greenwich St., New York 6, N. Y.

N-379 **Switchboard Tachometers.** Single-sheet 8½" × 11" illustrates and describes "Metron" indicating and controlling switchboard tachometers. Instruments are available in speed ranges from 1 to 100,000 r.p.m. and ½ to 10,000 f.p.m. Any number of heads for monitoring different machines from a single location may be used. Head selection by rotary switch. Metron Instrument Co., 430 Lincoln St., Denver, 9, Colo.

N-380 **Selector Switches.** 32-page 8½" × 11" Catalog, Form 722 illustrates and describes maker's line of selector switches, pressure switches and thermostats, for all electronic devices. Switch components are laminated phenolic or steatite sections, cadmium or nickel-plated metal parts, clips and contacts of silver-plated brass or solid silver. Centralab Div., Globe-Union Inc., Milwaukee 1, Wis.

N-381 **Thermometers.** 4-page 8½" × 11" Bulletin No. 46-3 illustrates and describes the "Palmer, Red-Reading-Mercury" thermometers. This line features an extruded brass case of V-shaped design, fume-resistant and dust-proof, with a double-strength glass shield easily removed for cleaning. Manufacturer also offers complete modernization service for old thermometers. Palmer Thermometers, Inc., 2501 Norwood Ave., Cincinnati 12, Ohio.

N-382 **Sub-zero Processing.** 4-page 8½" × 10¾" catalog section illustrates and describes maker's "Kold-Hold" cabinets for temperature of 150° F. below zero for metal working plants, metallurgists and tool shops. Maker claims this temperature of —150°F. is the lowest commercially available at the present time. Unit is of horizontal type permitting ease of loading and unloading any type of material. Bowser Inc., Refrigeration Div., Terryville, Conn.

N-383 **Draft and Pressure Controllers.** 8-page 8½″ × 11″ bulletin illustrates and describes maker's line of controllers including "Thermogage" flue-gas temperature indicator, "Dampertrol" operating from either draft or air pressure, "Steamtrol" operating from steam pressure and the "Lectricarm," a float or step regulator of almost unlimited applications. Cleveland Fuel Engineering Co., 606 Williamson Bldg., Cleveland 14, Ohio.

N-384 **Thermostatic and Pressure Switches.** 24-page 8½″ × 11″ catalog contains bulletins illustrating and describing maker's thermostatic and pressure switches for temperature and pressure control in marine, industrial, aircraft and special applications. Specifications, mounting detail and engineering data are included. United Electric Controls Co., 69-71 A St., Boston 27, Mass.

N-385 **Resistance Thermometer.** 10-page 7¾″ × 10½″ Bulletin 230-A illustrates and describes "Pyrotron" an electrical resistance thermometer which records as many ar four temperatures by continuous records on one circular 24-hour chart. Instrument is suitable for marine, mobile and other severe service where extreme vibration and motion are encountered. Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

N-386 **Sensitive R. F. Voltmeter.** Single sheet 8½″ × 11″ describes maker's "Model 300 Electronic Voltmeter" with high-frequency limit extended to beyond 5 megacyles. Instrument is claimed to fulfill need for voltmeter capable of indicating millivolts in television and m.f. intermediate frequency amplifier circuits. Ballantine Laboratories Boonton, N. J.

N-387 **Fractional Horse-power Motors and Generators.** 12-page 8½″ × 11″ bulletin illustrates and describes "Elinco Type FB" motors and generators. Manufacturing processes, general specifications and performance charts for each individual type are included. Electric Indicator Co., Stamford, Conn.

N-388 **Electronic Instruments and Accessories.** 32-page 8½″ × 11″ Catalog "C" illustrates and describes maker's line of electronic equipment which includes Q meters, Q. X. checkers, Beat frequency generators, F. M. signal generators, U. H. F. Circuit checker, oscillators, inductors and transformers. Boonton Radio Corp., Boonton, New Jersey.

N-389 **Bench-type Induction Soldering Unit.** 4-page 8½″ × 11″ bulletin pictures and describes portable bench-type induction soldering unit, designed for use wherever production soldering of small metal parts and assemblies is part of the job, but useful in diverse fields such as instrument shops and laboratories. Marion Electrical Instrument Co., Manchester, New Hampshire.

N-390 **Variable Transformer.** 4-page 8½″ × 11″ Bulletin No. 30 illustrates and describes "Powerstat" variable transformer with fuse protection, output receptacle and input cord and plug for laboratory and shop use. Fuse is positive and instantaneous in action when a short occurs—there is no danger of recycling after cooling down. Superior Electric Co., Bristol, Conn.

N-391 **Machlett Technical Announcer.** 16-page 7½″ × 8¾″ issue of this house organ (designated as No. 46-4-22) pictures and describes numerous items of equipment available from this laboratory supply house and features an article "Thermometry — Three Hundred Fifty Years of Progress" by J. J. Moran of Kimball Glass Co. E. Machlett & Son, 220 East 23rd St., New York 10, N. Y.

N-392 **Infrared Gas Analyzer.** 8-page 8½″ × 11″ Bulletin No. 18 pictures and describes maker's infrared gas analyzer, an infrared meter of high resolving power and zero dispersion. Instrument is of particular value in the petroleum, chemical and allied industries which require continuous analysis of components in a gaseous stream. Baird Associates, 34 University Rd., Cambridge 38, Mass.

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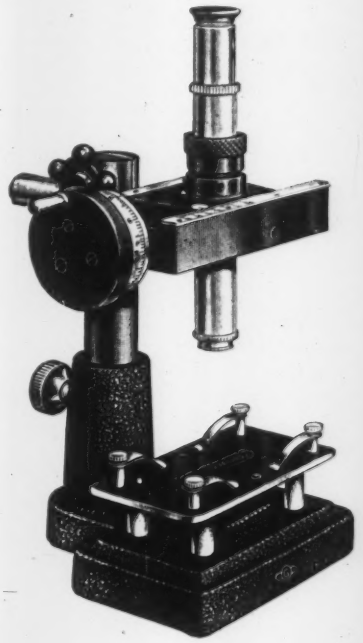

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